A NATURAL HISTORY OF PRE-SCHOOL CHILDREN'S BEHAVIOUR

ANNE E. JONES
Bachelor of Arts, University of Lethbridge, 2013

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ANNE E. JONES

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Louise Barrett Thesis Co-Supervisor	Professor	PhD
Peter Henzi Thesis Co-Supervisor	Professor	PhD
Lance Grigg Thesis Examination Committee Member	Associate Professor	PhD
Amy von Heyking Thesis Examination Committee Member	Associate Professor	PhD
Scott Allen Chair, Thesis Examination Committee	Associate Professor	PhD

ABSTRACT

Naturalistic observations in a free play day care were conducted to study motor and object manipulation behaviour in preschool-aged children. Behaviour settings theory, which predicts that setting has greater influence over behaviour than individual factors, was tested by comparing behaviour between indoor and outdoor settings. Analysis confirmed that there were motor and object manipulation rate differences across settings. Consequently, setting was controlled for in the second analysis, which looked at repetitive behaviour. Repetition is a central concept to Montessori educational theory and is used as a learning tool in Montessori classrooms; however, little information about repetition as a developmentally typical behaviour is available. A natural history of repetition was recorded to determine: activities during which repetition takes place; commonality of repetition across children; age that children most frequently engage in repetition; and length of repetitive bouts. Analysis revealed similarities and differences between Montessori's account of repetition and observed behaviour.

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CHAPTER I: GENERAL INTRODUCTION

1.1 Child Development and Theory

Developmental psychology is defined as the study of continuity and change that occurs between conception and death (Shaffer, Wood & Willoughby, 2005). Although developmental psychology now includes development across the lifespan, the field originates from the study of infancy (Burman, 1994; Baltes, Reese, & Lipsitt, 1980). Infants were studied to answer epistemological questions about the origins of knowledge. They were considered ideal study subjects because their limited experiences were argued to make them close to nature (Burman, 1994). According to this view, infants represented man in his purest form – unaffected by "civilization." Therefore, infants provided a means to answer how much knowledge is present at birth and what is learned through experience. Despite these origins, the place of epistemology in developmental psychology is ambiguous. Although the original questions that spurred developmental psychology are acknowledged in introductory texts, epistemological questions are not the central theme of child development. Instead, they appear alongside other themes, such as mechanisms of development, individual differences and children's welfare. It is now one item in a list of themes, rather than central to the discipline.

Studying infants became systematic and formalized in the 1800s when baby biographies were first published by natural scientists – Darwin being the most famous baby biographer (Lorch & Hellal, 2010; Thompson, Hogan, & Clark, 2012). Informal observations, however, date back to Ancient Greece, where Plato and Aristotle posed their epistemological views. Plato argued that children are born with innate knowledge, while Aristotle conversely proposed that knowledge comes from experience. These epistemological ideas formed the basis for two opposing schools of thought two thousand years later among Enlightenment philosophers.

The opposing views (knowledge as innate versus knowledge as learned) became formalized in the rationalism-nativism and empiricism debate, which is still of interest to child development researchers today (Spelke, 1998). Rationalism, now referred to as nativism, is the theoretical perspective best associated with the German philosopher Immanuel Kant. Kant proposed that we are born knowing concepts that are necessary to develop our understanding of the world, such as space, time and causality. These concepts provide meaning to what we perceive in the world. As Kant explained it: "percepts without concepts are blind."

In stark contrast, the British empiricists, namely John Locke and David Hume, suggested that we are born without knowledge of any kind. As Locke put it, we are born *tabula rasa*–blank slates–and all we know about the world comes from experience. Although we are born equipped with a mind, it is empty. Sensory information is impressed on our minds to create a mental copy of the world. We become knowledgeable about the environment through the accumulation of epistemic pieces.

Both of arguments, however, are insufficient for explaining how we come to know about the world. First, the empiricist argument is evolutionarily unsatisfactory. Evolution works to optimize chances of survival by passing genetic information from one generation to the next. It would not be evolutionarily advantageous for humans to be born blank, without any understanding of the world, or at least mechanisms to guide learning. If we were born blank as the empiricists suggest, there would be no way to filter or organize sensory information as it impinges on the infant's senses. As William James put it, the environment would be a “blooming, buzzing confusion” (James, 1983). All sensory stimuli would be equally engaging, despite not all stimuli being equally meaningful.

Research in ethology and child development tells us animals do differentiate between stimuli at birth. Young offspring are attuned to stimuli with adaptive significance. Konrad Lorenz demonstrated stimuli attraction in newly hatched goslings in his Nobel Prize winning imprinting study. Taking the place of a mother goose, Lorenz demonstrated that goslings attach to the first large, moving object seen at hatching. Lorenz did not need to closely resemble a female goose to produce following behaviour in the newly hatched goslings – a species-typical behaviour that Lorenz named imprinting. Imprinting demonstrates that goslings did not need a “mother goose” concept to attach to a mother figure. Instead, goslings attach to their mothers through a simple learning mechanism: identify a specific visual stimulus and follow the source of that stimulus. Although imprinting behaviour can go awry, as with Lorenz’s deliberate interference, imprinting is a robust adaptation that persists across generations.

Similar mechanisms are observed in human infants. Human infants attend to faces, but rather than reflecting the operation of a “face concept,” attention seems to be the result of simple learning mechanisms. It is not an attraction to faces per se that gains the attention of infants, but an attraction to facial configurations. Specifically, it seems to be the top-heavy configuration of faces, where more items are in the top portion than the bottom portion of the circumscribing shape. When presented with face images, infants were more attentive to upright faces than upside down faces (Cassia, Turati, & Simion, 2004). Furthermore, presenting infants with scrambled face images revealed that attention to faces does not rely on facial features being in the proper position. Infants paid equal attention to an upright, non-scrambled face and a top-heavy, scrambled face (i.e., with the mouth, eyes and nose all presented in the wrong positions) suggesting they perceived these as equivalent.

Other research on infant facial bias demonstrates that facial features are not required to attract infant attention. Geometric shapes in a top-heavy configuration are also attractive to infants. Turati, Simion, Milani, & Umilta (2002) presented infants with stimuli that consisted of squares circumscribed in head-shaped outlines. Infants were more attracted to top-heavy configurations, even when squares were skewed to the side (i.e., not centred in the head-shaped outline). When shown two top-heavy configurations, one with centred squares and one with skewed squares, the infants were equally attentive. Like the results from the scrambled face study, top-heavy configurations were the most salient and effective in capturing infants' attention. This study demonstrates that general patterns are enough to produce an attention bias.

Simple learning mechanisms allow infants to attend to sensory information that can increase the likelihood of survival. Human infants attend to the faces around them and learn the faces of caregivers, whom they depend on to survive. Gosling imprinting serves the same function. Close proximity to the mother helps goslings avoid predation. As these two cases have demonstrated, learning mechanisms do not need to be complex. To increase chances of survival, however, animals must be born with some knowledge to maximize dealings with the world.

As a result of the failures of a purely empiricist position to accord with evolutionary theory, rationalist-nativist theory, is offered as the preferred evolutionary explanation. Inborn concepts are said to be an evolutionary solution to problems continually encountered over generations. However, there is theoretical issue with this argument. Humans have long lives, which results in the selection of behavioural strategies that increase reproductive fitness for a long-lived animal. One example of such a strategy is high parental investment. Unlike a short-lived shrew that invests little in many offspring, humans have relatively few offspring and invest large amounts of energy into those few. This strategy increases individual fitness by producing offspring that survive to adulthood, who then also reproduce. Consequently, the population increases exponentially. Long lives, however, come at the cost of uncertain futures. Longer lives means individuals experience more variable conditions. A longer life gives individuals more opportunity to experience more changes in weather, landscape, resources and predation. Being able to adapt to new conditions, or learn, is valuable in a variable environment. Therefore, fixed concepts may not be useful for animals born into an uncertain world.

Research claiming to provide evidence for innate knowledge is equally questionable. The "core knowledge" movement aims to identify knowledge present at birth, or "humans' innate endowment" (Spelke, 1994). Core knowledge theorists argue that they are continuing the work of early rationalists-nativists, but with technological advances that were previously unavailable for studying infant cognition (Spelke, 1998). Core knowledge theorists study infants as early as possible to avoid observing knowledge acquired through learning. Access to infant knowledge is limited, however, due to the inertness of young infants. Unlike prococial animals, such as most ungulates and species of ducks and geese, which are born relatively mature and mobile, human infants are altricial. That is, humans are immobile at birth and rely on other members of the species for survival. Due to limited abilities during human infancy, core knowledge theorists use looking-time paradigms to assess an infant's knowledge, i.e., they record the amount of time spent looking at visual stimuli under the assumption that infants will attend more to novel or surprising features of the environment (although sometimes the reverse assumption is made, where infants are argued to be drawn to more familiar stimuli: see below for further discussion).

Looking time experiments are conducted on infants once they are a few months old, in order to ensure they have some eye and neck control. In a standard experiment, infants are presented with a visual stimulus until they become habituated, i.e., they display a decreased response to the stimuli as a result of becoming accustomed to it. Infants are then presented with novel stimuli. If the looking-time increases, it is assumed that infants have detected the change in stimuli. Core knowledge theorists thus make inferences about infants' knowledge and cognitive processes based on their recognition of novel stimuli.

Despite the technological advances that make looking-time experiments possible, there are methodological issues with core knowledge studies that limit their credibility. One major fault of core knowledge research is that inferences change based on researcher expectation (Tafreshi, Thompson, & Racine, 2014). Depending on experimental hypothesis, looking time is interpreted in one of the following ways: recognition of a change; preference; or violation of expectation. For example, core knowledge theory predicts that if infants understand that an event is physically impossible, they will look longer at this kind of event than a physically possible event: an infant will look longer at a scene where a ball appears to pass through a wall than a scene where the wall stops the ball if they understand that objects cannot occupy the same space. In this example, longer looking time is said to be a result of violated expectations.

Inferences change, however, based on experiment type. In some cases, longer looking times are explained as infant preference. In studies of audiovisual synchrony, for example, the inference is that infants look longer at synchronous events because they prefer them to asynchronous events. In one study, 4-month-old infants were presented with two films: one in which sounds of impact coincided with the "hopping" of a toy animal and another where the impact sound occurred when the animal was still in mid-air (Spelke, 1979). When infants looked longer at the synchronous event than the asynchronous event, this was taken to confirm the preference hypothesis. However, if looking time was considered a violation of expectation, one would expect infants to look at asynchronous events because they go against expectation. In this case, the violation of expectation hypothesis would be refuted. The inference of looking time thus changes to fit researcher predictions.

The rich interpretations made from simple looking procedures are another problem with core knowledge research. Originally, looking-time paradigms were used to study pattern detection during infancy (Fantz & Nevis, 1967). Now, looking-time procedures have been extended to assess infants' physical, mathematical, social, biological and moral knowledge (Tafreshi, Thompson, & Racine, 2014). In one social cognition study, infant looking time procedures were used to explain infants' understanding of pro-social and anti-social behaviour based on the movements of shape cutouts with googly eyes (Hamlin, Wynn, & Bloom, 2010). The infants were presented with scenes where a shape was either helping another shape up an incline, or pushing it down the incline. Researchers concluded that longer looking times directed at shapes pushing other shapes down the incline meant infants had a preference for helping over hindrance.

Conclusions drawn from this experiment thus impress adult-like understanding of social behaviour on infants. This is problematic considering that the social agents in the presented scenario were two-dimensional shapes with eyes – very unlike the social actors that infants have experienced in their short lives. It is a stretch to assume that infants recognize the stimuli as social agents. Haith (1998) therefore criticizes the “adultocentrism” of infant cognitive development, which is the tendency to think of infant cognition as similar to our own. Furthermore, Haith (1998) criticizes the manner in which looking time experiments, which use minimalist perceptual discrimination paradigms and can only tap into limited aspects of knowledge, are used to infer the operation of cognitive processes. In other words, many researchers make unwarranted inferences using the data from looking-time paradigms, when the most we can know is whether a change in visual stimuli has been detected.

In addition to evolutionary and methodological arguments against core knowledge theory, Linda Smith (1999) argues convincingly that innate knowledge is not necessary for cognitive development. The nativist argument holds that we must have innate concepts to begin the process of cognitive development: we cannot get something from nothing. Smith (1999) rejects this stance, arguing that something can come from nothing, or at least from something much less. Using embryology as an example, Smith (1999) describes how body parts, such as fingers and toes, are made from the accumulation of cells operating in real time to create these parts. It is not simply a matter of growing, tuning or refining already existing features– the original parts are very different from the final product.

Smith (1999) also explains how this process applies to knowledge construction. The recognition that concrete objects are named by their shape (shape bias) occurs in children as young as two years old. For example, a two-year-old who is told that the object lifting boxes is called a “forklift truck” can apply the label to an image of a forklift in his picture book.

Smith proposes that the shape bias emerges from a chain of events that take place over the child's first two years of life. Some of the steps include: learning the prosodic patterns of language; the transitional probabilities of speech segments and syntactic patterns; the increasing ability to use an adult's direction of gaze to visually locate a named object; and the emergence of words as special associates of objects. Knowledge is built up through developmental processes that occur over time.

Having refuted both rationalist-nativist and empiricist views on the origins of knowledge, there is need for a theoretical alternative. Constructivism is the epistemological position that knowledge is built through active engagement with the environment, with knowledge continually changing in response to our experiences. Therefore, constructivism is the building up of knowledge over time as described by Smith (1999). Consequently, constructivism rejects the rationalist-nativist notion that we are born with pre-existing knowledge-parts that form the basis of our understanding (Campbell, 2009).

Constructivism also rejects empiricist ideas. According to empiricism, representations of the world are created by sensory information being impressed on the knower by the environment; the knower is passive. This is at odds with constructivism, in which people are active in knowledge acquisition. We create meaning through exchanges with the environment (Ultanir, 2012). What we have then, are not pre-existing knowledge concepts or empty minds that passively receive information. Instead, we construct knowledge through our active experiences with the environment, which are guided by simple learning mechanisms, such as attentiveness to faces.

Three individuals are most often associated with constructivism: Jean Piaget, John Dewey and Lev Vygotsky. Piaget developed an interdisciplinary approach, using both psychology and philosophy, to study the origins of knowledge. Influenced by his training in biology, evolutionary theory was central to his constructivist theory, in which he proposed the constructive processes of knowledge (Messerly, 2009). Dewey applied constructivism to education, taking an approach that was counter to traditional views of education. Rather than assuming that knowledge was imparted from the instructor to the student, Dewey advocated for active student participation and self-direction (Ultanir, 2012). The child's experience was thus more important than the subject matter or curriculum: understanding was made of one's life experiences. Lev Vygotsky shared similar views, but was most interested in the social construction of knowledge, in which meaning is created on two planes (Liu & Matthews, 2005). First, it occurs on the social plane, with meaning shared between individuals, and then on the psychological plane, where shared meaning becomes internalized. In Vygotsky's constructivism, individual mastery and development does not occur in isolation, but is based on history and culture. Although Piaget, Dewey and Vygotsky emphasized different aspects of constructivism, they are united in the shared view that knowledge is constructed through meaningful experiences.

Along the lines of evolutionary explanations for knowledge acquisition, Piaget explained learning as the process of becoming adapted to one's niche. Individuals come to learn about and construct knowledge of their environment through processes Piaget calls assimilation and accommodation (Messerly, 2009). Through these processes, knowledge is constructed and re-constructed into cognitive structures, known as schemes. Since knowledge is acquired through exchanges with the environment, schemes are understood in relation to action. For example, infants develop sensorimotor schemes, which are simple knowledge structures that allow infants to understand that their motor actions have consequences on the world. For example, learning that a mobile over one's head will move when kicked is incorporated into a sensorimotor scheme. Throughout development, individuals develop increasingly sophisticated schemes, such as concrete operations that allow children to reason about classification and putting things in order.

Schemes are modified when applied to the environment. Assimilation involves applying a known scheme to a new, but appropriate, situation. The new situation is then included in the scheme. Accommodation occurs when a scheme is inappropriately applying to a situation. The scheme is recognized to exclude the inappropriate situation (Campbell, 2009). A child who has developed a fly-swatting scheme will apply that knowledge to swatting flies other than the original fly, i.e., the child has assimilated new scenarios to the fly-swatting scheme. However, if the child applies the fly-swatting scheme to a hornet, which results in being stung, the child will accommodate the scheme to exclude hornets. Through the assimilation-accommodation process, development tends toward a balance, or equilibrium.

Another appealing aspect of constructivism is that knowledge can be studied reliably. Knowledge is not pre-existing as rationalists-nativists suggest. Therefore, it does not need to be accessed in inert, pre-verbal infants. Instead, knowledge can be studied in as it is constructed during childrens' day-to-day lives. This developmental process is observable, and therefore, accessible to researchers. Part of Piaget's genetic (or developmental) epistemology was an empirical study of the growth and development of knowledge. Piaget believed that a theory that included empirical evidence as well as normative explanations of knowledge would provide a complete understanding of knowledge. Piaget's unique method for collecting empirical evidence included a combination of naturalistic observations and interviews (Bond & Tryphon, 2009).

While working in the Binet-Simon laboratories, Piaget realized that errors committed by children were more informative than their correct answers: the yes-no responses of standardized testing do not reveal *why* a child answers a question correctly or incorrectly. Consequently, Piaget began to engage children in conversation to uncover their reasoning process. He called this the “clinical method,” but later the “critical method” to avoid the method sounding pathological. Through these interviews, Piaget aimed to understand how a child comes to their understanding, by inquiring about the justification for their responses.

The core of Piaget’s method is clearly stated in *The Child’s Representation of the World*:

> In a few words, the method to follow in study of children’s representation of the world is this: observe the child naturally, note the child’s utterances and questions, and then, inspired by these questions interview other children directly; finally, return to pure observation in order to verify the results of the previous interviewing. The method is thus a short of shuttle between pure observation and interviewing, interviewing intended to increase the volume of data and direct observation intended to situate them in their spontaneous mental context (p.192).

Piaget’s methods were unorthodox compared to American psychologists performing experimental scientific methods followed by statistical analysis (Bond & Tryphon, 2009). However, his emphasis on using naturalistic observations as part of the empirical process is especially pertinent for the constructivist approach. Since children construct knowledge during their everyday experiences, observing them in their natural environments gives researchers access to the knowledge-building process. It is a wellspring of valuable information. Despite Piaget’s influential research and methodological recommendation, experimental research methods have come to be the norm within developmental psychology, or at least held as the ideal research method.

1.2 Child Development and Method

Within child development, there are "the great stories" that have helped define the field. In perceptual studies, Gibson's visual cliff experiment demonstrated depth perception in novice versus experienced crawlers; Mischel's Marshmallow Task introduced individual differences in children's ability to resist temptation, including strategies for exercising executive control; learning theories offer the cautionary tale of classical conditioning with Watson's Little Albert, and the power of social learning with Bandura's Bobo Doll experiment; the three main forms of infant/child attachment behaviour are identified with Ainsworth's Strange Situation Test. These stories present new students of child development with a sample of child development research. Not only do they introduce major topics within child development, but these stories also implicitly present an expectation of how research should be conducted.

Thus, most classic stories of child development feature laboratory experiments. The standard procedure is to bring participants into an artificial setting, present them with an experimental condition or task, and compare them to control conditions. The ubiquity of laboratory experiments suggests that they are considered to be "the method" of the discipline, despite the use of other methodologies by well-respected researchers. Ainsworth is best known for the Strange Situation Task, for example, in which she created an experimental scenario whereby infants were exposed to strangers and their reactions recorded. Despite the Strange Situation being the work for which Ainsworth is best known, it was one of five methods that she used in her famous Baltimore study. Ainsworth also conducted a longitudinal observational study in Uganda looking at natural interactions between the mother-infant pair (Ainsworth, 1967).

Excluding the other methods used by Ainsworth to study infant attachment from the classic stories of child development is thus revealing. The view that laboratory experiments are the gold standard of research is not exclusive to child development, however. Brannigan (2004), commenting on the misused of experimental design in social psychology, wrote that it is well accepted within the social sciences that experimentation is the key to objective knowledge, and is superior to other methodologies.

One reason why experimentation is considered the gold standard can be traced to the way in which the history of psychology is tied to the physical sciences (Hergenhahn & Henley, 2014). Psychological questions can be traced back to the early Greeks, but scientific achievements during the Enlightenment period led to psychological questions being addressed through experimentation. Physiology was particularly involved in the birth of experimental psychology, as it provided answers on how external events came to be represented in consciousness, particularly through the study of physical stimulation and sense receptors. Through experimentation, psychology became distinguished from philosophy. The superiority of the experimental method is not expressed explicitly (many introductory psychology courses discuss the pros and cons of each method), but presenting only laboratory experiments as the classic stories of child development implicitly suggests that experimentation is the preferred method.

While there is no doubt that laboratory experiments are a powerful tool for addressing questions within psychology, enabling causality to be addressed more effectively, the very fact that they require highly controlled artificial set-ups in order to demonstrate causality has the effect of limiting external validity. Thus, there is still a place for naturalistic observations of children's development, which can provide evidence to suggest whether the results of laboratory experiments are generalizable and have application in real world situations. When observing children, this means research is conducted in homes, schools, day cares, playgrounds or any environment typical of the child's day-to-day life. Behaviour in these settings is recorded with minimal interference from the observer. In stark contrast to laboratory experiments, conditions are not manipulated in naturalistic observations, and the researcher's interest is in how behaviour naturally occurs within the context of the environment. Despite the drastic differences between these approaches, Pellegrini (2013) advises that naturalistic observations and laboratory experiments should not be considered adversaries. Instead, they are complementary. Naturalistic observations and laboratory experimentation have different advantages when answering questions about the world, but their greatest advantage comes when used in combination.

1.3 Laboratory Experiments and Naturalistic Observation

The major advantage of naturalistic observations is in question and hypothesis generation. Although naturalistic observations are time-consuming (for example, Ainsworth's naturalist observations over the first year totaled to 1,768 hours of observation for twenty-six infants), naturalistic observations provide researchers with insight that is not possible through other methods. Observing behaviour allows researchers to understand the repertoire of an individual's behaviour, as well as the day-to-day contexts that influence behaviour.

We can return once again to Mary Ainsworth's work to illustrate the drawbacks of developing an experimental research question without thorough knowledge of naturally-occurring behaviour (Ainsworth, 1967). When she arrived in Uganda, Ainsworth's original intention was to conduct a natural experiment looking at the effects of weaning on attachment. Ainsworth's plan, which was based on Western conceptions of Ugandan weaning practices, was to compare traditional and non-traditional weaning practices. It was reputed that traditional weaning was abrupt: infants were brusquely separated from their mother to be cared for by other relatives. This custom was reported as "sudden and traumatic." It was also thought that non-traditional weaning practices were also present. Non-traditional weaning was thought to be gradual, making a good comparison to the traditional method. Ainsworth had planned to establish baselines of attachment behaviour (prior to weaning), and compare infant responses to traditional and non-traditional weaning once it took place.

When Ainsworth arrived in Uganda, however, it was soon apparent that Western conceptions of traditional weaning were inaccurate. Abrupt weaning was not customary. Consequently, Ainsworth was not able to conduct the natural experiment she had originally set out to do. Instead, she modified her study plan to describe Ugandan customs of infant care in the first fifteen months of life. She therefore observed and recorded the course of development, particularly in regard to relationships and attachment behaviour and, from these, ascertained the effects of variation in infant care on development.

Ainsworth recorded the natural histories of twenty-eight mother-infant pairs, which then laid the foundation for her later experimental work. In addition to creating a catalogue of behaviour, Ainsworth was able to conclude: i) there is no single attachment behaviour that serves as a criterion for attachment; ii) development passes through phases; iii) there are individual differences toward the end of the first year, which are related to maternal behaviour; and iv) infants become attached to multiple figures.

Ainsworth experience in Uganda provides a cautionary tale for experimentalists. Ainsworth had the opportunity to recognize that her original understanding of Ugandan weaning was inaccurate. Not all researchers, however, have the opportunity to observe behaviour in its natural environment and so identify potential problems with their underlying assumptions. Conducting research in laboratory settings alone, completely separated from natural behaviour can lead to experimental work becoming increasingly removed from the lived experience of the children it purports to study; each experiment that is based on the work of a previous experiment, which is also based on previous experiments (Blurton-Jones, 1974). It thus becomes difficult to know whether the experimental questions or hypotheses are representative of behaviour occurring in natural settings. Natural histories eliminate this problem by helping researchers identify the important questions to ask, and provide a means to ensure that research is relevant to the world outside the laboratory.

1.4 Constructivism and Naturalistic Observations

As should be apparent, given the above, naturalistic observations are necessary in a constructivist framework. Knowledge acquisition happens in day-to-day contexts as individuals act, react and change their environments. Therefore, understanding knowledge acquisition requires a natural history of how children behave in the world. Detailed descriptions of behaviour in naturalistic contexts help researchers understand what children learn, the contexts in which learning takes place, and the behaviour that enables learning. Once this has been established, other methods, such as experimentation or interviews, can be used to verify observational findings.

A constructivist approach to development is necessarily concerned with children's ability to act in the world. A child's ability to move through the world and manipulate physical features of the environment affects opportunities for learning, simply by changing what children have access to: climbing allows children to explore new areas of the environment and fine motor control allows children to experience objects in new ways. Additionally, a body of work known as "embodied cognition," proposes the mutuality of action and cognition, in which the sensory-motor system provide structure for conceptual content (Gallese & Lakoff, 2005). There are developmental examples of how action affects understanding of the world. Infants who actively explore the environment with their hands better understand object boundaries than less active infants (Needham, 2000). Locomotion also drastically changes how infants experience the world; for example, locomotion leads to infants developing a fear of heights (Campos et al., (2000). Although these are examples of infant development, there is no reason to suppose that the link between action and cognition does not extend into the preschool years.

Currently, however, there is a gap in the literature concerning motor and object manipulation development among preschool-aged children. There is extensive work in these areas in regard to infant development. Infant motor and object manipulation behaviour is studied to understand what aspects of the physical environment infants learn about early in life – e.g., layout and objects (Gibson & Pick, 2000). Similar work on young children, however, is not available. One reason for this may be due to preschoolers having developed sufficient motor and object manipulation skills to get around in the world. Therefore, preschoolers motor and object manipulation behaviour may be viewed as less exciting than the dramatic advances seen in infancy, where babies shift from immobility to mobility, and gain the capacity to grasp, manipulate and investigate objects. Similarly, motor and object manipulation development during the preschool years may be neglected because researchers are interested in “cognitive” research topics, because this is the developmental period where the dramatic gains are seen in other capacities, such as the so-called “theory of mind.”

It is also the case that many naturalistic observational studies conducted currently are policy-driven, preschool education assessments. Such studies address academic readiness by measuring skills like language ability and mathematical reasoning (Fulingni, et al, 2010). Some studies also assess learning behaviour, or learning approach, which includes behaviour such as curiousity, competence, motivation, imitative, persistence, planning, problem-solving and cooperation with peers (Dominquez, Vitiello, & Greenfield, 2010). Motor and object manipulation behaviour may be considered too rudimentary for the study of higher cognitive functioning.

From a constructivist view, however, motor and object manipulation development also contribute to cognitive development by increasing one’s ability to effectively act on and learn about the world. Although preschoolers have already reached major locomotor and manipulation milestones, object manipulation skill (Keen, Lee, & Adolph, 2014) and motor skills (Sinclair, 1973) continue to be refined throughout early childhood. Studying object manipulation and motor development during the preschool years can reveal how developing these skills influences further engagement with the environment, and consequently, knowledge acquisition.

1.5 Purpose of This Project

Thus, the purpose of this project is to bring attention to a neglected area of child development – motor and object manipulation development during the preschool years –

using a constructivist framework and naturalistic observations. Specifically, my study uses naturalistic observations to test hypotheses derived from behaviour settings theory and Montessori education theory.

The first part of the project applies motor and object manipulation behaviour to behaviour settings theory. This is a general theory about behaviour – not specific to motor and object manipulation – nor specific to developmental theory, but as discussed in more detail in Chapter 3, it offers a way to characterize the manner in which environmental features factor into behavioural patterns. It thus provides a mean by which I can determine those factors that need to be statistically controlled for in my analyses of motor and object manipulation behaviour, thus compensating for my lack of experimental control. That is, determining whether there are differences across different environments (behaviour settings) in motor and object manipulation rates provides the necessary background to the main focus of my study, which is the role of repetitive behaviour skill acquisition, and specifically its application to Montessori education.

As I discuss in greater detail in Chapter 4, Montessori developed her educational theory based on close observations of children's behaviour in the classroom. These observations led her to include repetition as foundational to her educational approach. Montessori's descriptions of repetition are vague, however. A systematic exploration of children's spontaneous use of repetition behaviour is therefore needed to validate (or question) the role of repetitive behaviour in children's educational development. This project will therefore present the commonality of repetition across children, repetition bout length and age in which repetition is most likely to occur, as a means to test whether these fit with Montessori's original anecdotal descriptions.

CHAPTER II: METHOD

2.1 Introduction

Naturalistic observational data was collected on thirty-one preschool-aged children during free play over eight weeks. Free play was defined as activities chosen by the children, during which they chose how to do the activity and when to stop (Santer, Griffiths, & Goodall, 2007). Free play had no external goals set by adults; instead, children led the play sequences. Activities such as circle time, snack time and designated craft time were excluded from observations. Activities set out by adults, such as play dough or colouring sheets that were not mandatory or directed were included in observations. That is, activities in which children had a choice as to whether they participated and how they engaged with the materials were included.

2.2 Study Site

Observations took place in four indoor classrooms (Junior 1, Junior 2, Senior, and Kinder) and one outdoor space at a non-for-profit day care, attended by up to eighty-four children, which employs 18 full time staff members. Class membership was exclusive, and each participant was only observed in his or her classroom and the outdoor space, which was shared by classes in the study. Although children were only members of one class at a given time, two focal children changed classrooms during the study. They were excluded from analysis.

Each classroom varied in layout, but they generally had the same play centres: book centre, sand and/or water table, dramatic play centre, art centre, building centre and puzzle centre. Some centres were unique to a specific classroom: Junior 1 had a fish centre with a viewing perch; Junior 2 had a quiet box, where a child could sit in when they wanted to be alone; Senior had a writing centre; and both Junior 2 and Kinder had a miscellaneous centre, where activities were periodically changed by adults. Miscellaneous centres during the study period were tech, nature, playdough and train centres (see Appendix 5 for toy changes). The outdoor space included a swing set, slides, sandpit, play house, climbing poles and a large, centre green space. Occasionally, part of the deck was opened for bike and scooter play. Two areas of the outdoor space were off limits to the children: part of the deck was always gated and reserved for infants; and part of the yard was fenced off for toddlers, who were not part of the study.

Figure 2.1. Junior 1 classroom

Figure 2.2. Junior 2 classroom

Figure 2.3. Senior classroom

2.4. Kinder classroom

Figure 2.5 Outdoor play area

2.3 Participants

Participants were thirty-one children ranging from 33 to 72 months of age. Classroom membership was based on age. Although class membership is determined by age, developmental readiness is also taken into consideration when children transition into an older age group class. Alberta government adult-child ratio guidelines (Government of Alberta, 2013) and age of participants are listed in Table 2.1 for each class.

Table 2.1. Age group and adult-child ratio for each classroom

Class	Adult-child Ratio	Age Range of Focal Children
Junior 1	1:6	33 – 40 months
Junior 2	1:8	41 – 49 months
Senior	1:8	50 – 60 months
Kinder	1:10	61 – 72 months

Parent/guardian consent forms were signed for all children (focal and non-focal) in the four classrooms prior to random selection of focal children (children who would be directly observed). Although children were randomly selected, there were some restrictions on which children were included on the selection list. Children who the day care director indicated would be leaving the day care or transitioning during the study period were not included. Additionally, in the Kinder room, approximately half of the children had a school schedule that prohibited them from being present during most of the observation periods; therefore, they were also excluded. For the Junior 1 room, there were only seven children that met the qualifications for inclusion, so they were all chosen as participants. For the other classrooms, eight children from each classroom were randomly selected. The number of participants was chosen based on what would be a manageable number of children to observe during an observation session (approximately three hours in length).

2.4 Procedure

Before data collection, seven days were spent in practice observations to fine-tune data collection methods and habituate the children to the presence of an observer. I sat unobtrusively in areas out of the line of direct traffic, but still within view of the child being observed. The children did not appear bothered by having a new adult in the room. This was expected as children are accustomed to having new adults, such as practicum students or support workers, in the room. Some children approached me during observations (particularly children in the Senior and Kinder classrooms), but went back to playing when they realized I was not engaging in conversation, aside from simple answers to their questions. There was nothing to indicate that children were uncomfortable or acting outside their normal routines. Once I began collecting data, they generally ignored me.

Each day, there was a morning and afternoon observation session. The observation schedule was based on the children's schedule. Junior 1 and Junior 2 classrooms were only observed in the morning because they napped for a large portion of the afternoon. The Senior and Kinder classes, which do not have nap times, were only observed in the afternoons. Typically, only one class was observed during a session. The Junior 1 and Senior classrooms were observed on the same day, and the Junior 2 and Kinder classrooms were observed on the same day. Observations of Junior 1/Senior and Junior 2/Kinder alternated from day to day.

Children were observed during free play periods. Observation sessions typically occurred from 08:00 to 11:30 in the morning and 13:00 to 16:00 in the afternoon. Transition periods from indoor to outdoor play and/or group activities typically occurred during these times. Observations were halted until free play resumed.

Table 2.2. General day care schedule

Time	Activity
07:30	Day care opens and drop off begins – all children begin day in Junior 2 room
08:00	Children go to their own classrooms for free play
09:00	Morning snack – children are free to continue playing when finished snack
10:00	Free play
10:30	Children get ready to go outside
11:00	Morning drop off ends
12:00	Lunch
13:00	Nap time for Junior 1 and Junior 2 classes/free play for Senior and Kinder classes
15:00	Afternoon snack/free play – pick up begins
15:30	Children get ready for outdoor play
18:00	Day care closes

Data were collected on an iPhone 4 using the Microsoft Excel application. Children were observed in focal follows: a given child was observed exclusively for a twenty-minute periods. It was common, however, for children to leave the observation area (for example, to go to the bathroom). If a child left during a focal follow, data collection stopped and resumed when the child returned to the observation area. If the child did not return to the room within ten minutes, the focal session would end and a new focal follow would begin.

During follows, detailed action descriptions were recorded. Location and social partners were recorded concurrently with activity; that is, each action has a corresponding location and social category. Although the Excel spreadsheet did not allow continuous time data to be recorded, time was recorded for five-minute increments. Data were collected for a total of 101 hours. Total focal minutes for each child ranged from 157 to 210 minutes. See Appendix 2 for full list of focal follows and observation times.

CHAPTER III: ECOLOGICAL PSYCHOLOGY

3.1 Introduction

Naturalistic observations are valuable for identifying the relationship between animals and their environment (Pellegrini, 2013). Obviously, laboratories are also contexts for behaviour – they are environments that people engage with and are influenced by – but these are contrived to produce controlled experimental outcomes. In contrast, naturalistic environments are the conditions of every day life: the conditions under which learning and development occur. Thus, although they lack experimental control, naturalistic observations are necessary for a complete understanding of the complex and bi-directional relationship between animals and their environments. Traditionally, such relationships have not been central to psychology. Instead, conventional cognitive and developmental psychology has modeled itself as an experimental laboratory science, which assumes that the individual alone is the locus of psychological phenomena. It is also true, however, that there have always been alternative schools of thought within psychology, beginning with the likes of William James and John Dewey, which reject this conventional stance and argue for a relational approach to psychological phenomena. In what follows, I review the schools of thought most pertinent to my study, namely ecological psychology and behaviour settings theory.

3.1.1 Ecological Psychology

Ecological psychology draws on the biological science of ecology (Charles & Sommer, 2012). Ecology provides detailed descriptions of habitat, and describes organisms' relationships to their habitats, which includes other organisms, in terms of their adaptive significance. Ecological techniques are less often applied to humans than other species, which may be due to a supposition that the environment influences humans less than other animals. Indeed, it is true that humans have successfully exerted control over our environment, but the ability to change the environment does not mean that we are not influenced by it. An ecological approach allows the nature of human-environment relationships to be studied.

The term "ecological psychology" is commonly used to refer to the work of James J. Gibson and Roger Barker. Both psychologists recognized the mutuality (Gibson), or coupling (Barker), of animal and environment. They also acknowledged the absence of animal-environment relationships in psychological research, and changed their research approach to account for these relationships. In this respect, it is important to note that neither psychologist opposed laboratory experiments. Indeed, Gibson primarily engaged in experimental work, and Barker conducted his fieldwork with the intention that it would be experimentally verified. Both researchers, however, agreed that mid-twentieth century psychology needed to change how engagement with the environment was theorized and studied.

3.1.2 Gibson's Ecological Psychology

James J. Gibson's concern was that laboratory experiments did not adequately represent people's experiences of the environment (Gibson, 2014). Primarily interested in visual perception, Gibson initially used traditional experimental techniques to study these processes, but his experience led him to recognize their inadequacy. Standard visual perception research presents stimuli to participants on a screen, often via brief flashes of exposure. Visual perception is tested this way based on the underlying assumption that eyes function like a camera, an idea that stems back to 17^{th} century mathematician and astronomer, Johannes Kepler (Barrett, 2011). Like images captured by a camera, it is supposed that visual stimuli is captured as two-dimensional, inverted snapshots on the retina. An explanation for how these simple images lead to an understanding of the world was hypothesized by Hermann von Helmholz. Helmholtz argued that in order for these two-dimensional images to accurately portray the three-dimensional world, we must unconsciously infer meaning to fill in information gaps and create representations of the world. The view that we create mental representations in our heads – due to information from the world being sparse – is currently the conventional view of perception.

Gibson, however, rejected that view that the environment as impoverished and needing supplementation (Gibson & Pick, 2000). According to Gibson, the environment is information-rich, and we are not reliant on mental representations of the world to give it meaning. Information is available to perceivers as they move through the environment and seek out information. Therefore, Gibson concluded that the study of visual perception needed to represent how perceivers actively pick up information from their environment.

According to Gibson's perceptual theory, perception is the process of becoming increasingly connected to one's environment (Gibson & Gibson, 1955). This is in direct contrast to enrichment theories of perception, which explains perceptual learning as the strengthening of mental representations: as mental representations are strengthened, the perceiver becomes less dependent on environmental information. In contrast, Gibson and Gibson (1955) propose that perceptual learning occurs through two processes: differentiation, the process by which individuals make finer and finer descriptions of perceptual stimuli, and realization of affordances, learning the fit between animals and features of the environment.

An illustrative example of differentiation learning was demonstrated in a laboratory experiment, in which participants learned to differentiate variations of drawn coils (Gibson

& Gibson, 1955). Participants were asked to match images to a target stimulus: a four-loop coil. Among non-similar stimuli, such as a triangle, cloud-like shape and tree-like shape, were coils varying in compression, orientation and number of loops. Although participants initially chose all coils as matching the target coil, participants began to discriminate between coil variations, and began to choose only the exact replica of the target image. The participants did not learn through performance feedback, i.e., participants were not told when they were correct or incorrect. Instead, participants learned to discriminate coils based on repeated experience.

The second concept central to Gibson's theory of perceptual learning is the concept of affordances. An affordance specifies a particular kind of relationship between animal and environment. When we learn about the environment, we learn about it in terms of the opportunities for action it offers, or affords, us. Gibson describes an affordance as: "…neither an objective property nor a subjective property; or it is both if you like. An affordance cuts across the dichotomy of subjective-objective and helps us understand its inadequacy. It is equally a fact of the environment and a fact of behaviour. It is both physical and psychical, yet neither. An affordances points both ways, to the environment and the observer" (Gibson, 2014). The concept of affordances is distinctive and somewhat difficult to understand. In fact, the concept of affordance is often used incorrectly (Norman, 1999). It becomes clearer, however, through examples.

Affordances differ between species and individuals. For example, a balance beam affords cartwheels for a gymnast, but not for most people. There are also affordances that will never exist for a species: water never affords support for a human, even though it does for a water bug. However, affordances that were previously unperceived can become realized. The process from unperceived to perceived affordances is made clear in Eleanor Gibson's work, where the theory of affordances is applied to infant development. Although affordances are learned throughout life, learning is particularly prolific during early life when individuals have had few experiences. During this period, infants are primarily occupied with learning about layout, objects and members of one's social group (Gibson and Pick, 2000).

Learning the faces of one's caregivers presents an example of perceptual learning through discrimination and realization of affordances. As mentioned in Chapter I, infants are born highly attentive to face-like stimuli. However, at six-months old, infants cannot differentiate between human and monkey faces. It is not until nine to twelve months that infants go through a period of "perceptual narrowing," which allows infants to differentiate between human and monkey faces (Fair, Flom, Jones, & Martin, 2012). A similar process in language learning, in which infants become better at discriminating the speech sounds of their native language, also occurs during this time (Werker, 1989). Infants become finely attuned to perceptual information in their specific environments. Instead of continuing to be generalists, they become experts in human faces and their native language through differentiation.

Learning about faces also involves learning affordances. Learning to communicate with others requires acting on the affordances offered by other people, and understanding how one's own behaviour affords certain responses in communicative partners (Gibson & Pick, 2000). Faces provide communicative value, for example, by bringing infants' attention to important features of the environment by following eye gaze; and infants learn the affordances of their own actions in face-to-face interactions with caregivers. This is demonstrated in the bi-directional influence of gestural imitations between infants and caregivers.

Gibson's ecological psychology is compelling in how it proposes animals learn about their environment. The concepts of differentiation and affordances provide a useful way to think about how animals perceive their environment, while accounting for individual differences. Roger Barker's behaviour settings theory has a similar concept to affordances, which also links people to their environment. In behaviour settings theory, behaviour and environment are linked through synomorphs – the complementary relationship between behaviour and the environment, or milieu. Barker's theory, however, describes behaviour en mass rather than individual differences. Synomorphs and affordances provide a means to link behaviour and environment, which is particularly difficult in the complex and variable environments of day-to-day life. To account for this variability, Barker attempted to systematically organize the environment in a way that could be used to explain behaviour.

3.1.3 Behaviour Settings Theory

Barker's ecological psychology differs from Gibson's in that it is less philosophical, and takes a more applied approach to studying animal-environment relationships. Like Gibson, Barker was critical of psychological research in the mid-1950s. He argued, while psychology knew a lot about people in laboratory settings, it did not know how people behaved in day-to-day life. There was little understanding of the factors that influenced human behaviour, and therefore, limited what psychology knew about the range of human behaviour.

Barker believed that psychology needed natural histories of human activity. Part of this required addressing the complex environment of everyday life. Specifically, Barker

(1968) asked: “among the limitless attributes of a person’s surroundings, which ones are relevant to behaviour, and how does one identify and measure them?” (p.1). To answer these questions, Barker conducted a decades long research project in an American Midwestern town, which he referred to as “Midwest.” Barker’s attempt to tackle the complex environment of day-to-day life is the distinguishing feature of his ecological approach. Barker believed the study of behavioural context was the greatest challenge to psychology (Barker & Wright, 1954). Taking on this challenge, Barker and his associates collected extensive data on an entire town and its inhabitants, and organized the data in a systematic way that could be used by others to measure behaviour and settings.

Specifically, Barker and his research assistants conducted day-long observational follows of children in Midwest. During these follows, it became apparent that behaviour was highly dependent on setting: the greater number of settings, the more variable the behaviour (Barker & Wright, 1954). Abrupt changes in behaviour occurred when individuals moved between settings. The following observations by Barker and Wright (1954) demonstrate this point:

> “Margaret Reid’s hyperactivity, aggressiveness, and verbalization, gave way like magic to passivity, submissiveness, and silence when she passed from the synomorph Home Outdoors to synomorph Neighbour’s Birthday Party. The second graders cease writing, reading, spelling, sitting, whispering, etc., with startling swiftness and unanimity when they cross the line from School Academic to the School Playground” (p.9).

People’s behaviour changed across settings, but behaviour between people within a setting was similar. Furthermore, it was independent of the people in the setting. That is, settings had standing patterns of behaviour that persisted regardless of the individuals present. Those in the drug store, Sunday school classes, 4-H meetings or football games, engaged in standing patterns of behaviour specific to that setting. There may be more than one standing pattern per setting: there is both football playing behaviour and spectator behaviour at a football game, for example. Players behave according to the rules of the game. Spectators sit in the stands, face the centre field, attend to players and the ball, cheer and holler. Any one or all of those individuals could be exchanged and these standing patterns of behaviour would persist.

Based on these observations, it was evident that the next step was deciding how to identify and parcel these settings, with their standard patterns of behaviour, in systematic fashion. According to Barker, formally identifying a behaviour setting was possible because the world is not homogenous. Rather, it has structure, and behaviour settings are physically and temporally bounded units. Barker created the criteria of a behaviour setting by listing its essential attributes. The attributes are clearly defined and can be used by other researchers to identify behaviour settings:

i) Behaviour settings must have one or more standing patterns of behaviour. Individuals in a behaviour setting perform standing pattern of behaviour en mass. Standing patterns of behaviour do not include common behaviour elements among individuals, such as the twang of Midwestern speech or the cultural greeting of a handshake. Instead, the pattern of behaviour is particular to the setting. Furthermore, behaviour settings are not dependent on the individuals involved.

ii) The pattern of behaviour must be tied to the milieu. This includes both man-made parts and natural features of the landscape. Like standing patterns of behaviour, the milieu stands independently. It continues to exist regardless of standing patterns of behaviour.

iii) The milieu must be circumjacent to the behaviour pattern. Temporal and physical boundaries of the milieu surround the behaviour pattern. There are no breaks in these boundaries: for example, a shop opens at 9:00 AM and closes at 6:00 PM. There is no interim time when the shop is closed.

iv) The milieu is synomorphic to the behaviour. Synomorph describes the relationship between the behaviour and the milieu. This includes the relationship between behaviour and boundary of the milieu (the boundary of the football field also denotes the space where the game takes place), and the synomorphic elements within the boundary. For example, in a church service, the behaviour of the congregation, facing the preaching minister, reflects the set up of physical attributes of the milieu. The pews face the pulpit. The behaviour-milieu parts, such as the listening behaviour of the congregation and the pulpit-facing pews, are synomorphs. Behaviour settings consist of multiple synomorphs.

v) Synomorphs of a behaviour setting are interdependent. Synomorphs within the same behaviour setting are more similar to one another than the synomorphs of other behaviour settings.

Barker devised a system to identify independent behaviour settings. First, settings are distinguished from non-settings according to the structure test. To be a behaviour setting, the setting must be a behaviour-milieu synomorph. It must have (i) a standing pattern of behaviour, such as the play behaviour of children in a day care. Behaviour must be (ii) anchored to a milieu complex. For example, play behaviour always takes place within the building and yard of the day care. Behaviour must (iii) have particular time-space loci, such as the day care always being at the same location, and open at the same time. Behaviour settings (iv) must be synomorphic. For example, children in a day care respond to the open space of a yard by running, the swing set by swinging, and art materials by creating artwork: the children's activities are tied to the structures and materials of the day care environment. Finally, (v) the milieu is circumjacent to the behaviour. Children's behaviour occurs within the milieu, surrounded by the walls of the yard and the walls of the indoor classrooms. Once a behaviour setting has been determined, it can be compared to other behaviour settings using the interdependence index to determine whether it is independent (see 3.4.2 Behaviour Settings Interdependence Survey). Independent behaviours settings will have greater differences in behaviour than interdependent behaviour settings.

3.2 Research Aims

The purpose of the present study is to assess the usefulness of Barker's behaviour settings theory in explaining the link between behaviour and environment. Both Gibson and Barker's ecological theories have concepts that link behaviour to the environment: affordances in Gibson's theory and synomorphs in Barker's theory. Only Barker, however, produced a system for identifying how these linkages influence behaviour. Barker's research project of cataloguing an entire town according to behaviour was a massive undertaking. Creating a survey to identify behaviour settings is unique and distinctive of Barker's ecological psychology. The appeal of behaviour settings theory is that its predictions can be applied to all settings that meet the criteria of a behaviour setting.

Behaviour settings theory applies to people of all ages. Wohlwill (1980), however, called for behaviour settings theory to be applied to child behaviour. He viewed behaviour settings theory as a solution for developmental psychologists attempting to understand the influence of physical-environmental variables. Consequently, it has been used to study children's behaviour in a variety of settings (Görlitz, Harloff, Mey, & Valsiner, 1998), including preschool-aged behaviour in day care settings (Moore, 1986; Cosco, Moore, & Islam, 2010). When explaining behaviour in terms of behaviour settings theory, however, Barker's behaviour settings survey is not always applied. In Moore's (1986) study of classroom play areas and Cosco, Moore, & Islam's (2010) study of outdoor play areas, areas within the same space are considered separate behaviour settings. For example, play centres in the same room are considered separate behaviour settings. As Barker's behaviour setting survey was not applied in these studies, it is questionable whether they are truly independent settings. Behaviour setting predictions are based on the behaviour settings survey; it is, therefore, an essential component in behaviour settings theory.

The present study will apply behaviour settings theory to a day care environment by using Barker's behaviour setting survey and testing hypotheses derived from the theory. First, I apply the behaviour settings survey to the indoor and outdoor settings at a day care environment. This allows me to assess the applicability of behaviour settings theory to my study site. Second, behaviour setting theory will be tested comparing the motor and object manipulation rates of children in indoor and outdoor settings. This tests Barker's hypothesis that individual children's behaviour should be more variable between, rather than within, behaviour settings.

This study also provides a unique scenario for studying behaviour settings theory by incorporating children of different ages. Behaviour within a setting is supposed to be similar across children, despite individual factors, such as age. While this is plausible, children of different ages show different behaviour patterns, reflecting their developmental stage, so it is worth investigating whether this hypothesis holds true in this specifically developmental context. This study has the additional benefit of both shared and segregated spaces for varying age groups. Therefore, we can assess whether children of different age groups behave differently in separate indoor settings, but similarly when brought together in a shared outdoor setting.

3.3 Research Predictions

In line with behaviour settings theory, I predict that children's behaviour will show more similarity within settings than between them. Specifically, I predict that, (i) children within a given age-group/classroom will show marked differences in their rates of motor and object manipulation behaviour when comparing across indoor and outdoor settings. When considering the single outdoor setting alone, I predict that (ii) children's behaviour will be more similar, regardless of age. Finally, I predict that, when considering the indoor settings alone, (iii) children's rates of behaviour will differ across the indoor settings. That is, the single outdoor setting should produce more uniformity across all children, regardless of their age, compared to the variable indoor settings. As age and setting are confounded in the indoor setting, I cannot demonstrate that any such variability reflects differences in the children's age or the nature of the indoor setting per se. However, if there is similarity across ages outdoors, and variability indoors, this would suggest strongly that children's age is less important than setting in producing behavioural differences. In contrast, if there is variability both indoors and outdoors according to children's age, this would suggest that age is more influential than setting.

3.4 Methods

3.4.1 Data Collection

Data collection took place between April 27th, 2015 to June 18th, 2015 at a free-play day care in a mid-sized Northern Albertan city in Canada. Naturalistic observations were recorded for thirty-one children, who ranged in age from 33 to 72 months (mean = 50.94, S.D. = 11.56). Each child was assigned to a particular classroom, where membership was based on age. Children in the Jr.1 room ranged from 33 to 40 months; children in Jr.2 were 41 to 49 months; children in the senior room were 50 to 60 months; and children in the Kinder room ranged from 61 to 72 months. Two children (Child-6 and Child-30) unexpectedly changed classes during the study period and were excluded from analysis.

Each child was observed during twenty-minute focal follows (mean duration = 15.69 per child). The focal was paused if focal child left the room, and resumed when they re-entered. If the child did not return within ten minutes, a new focal on a different child would begin. In total, 101 hours of total observation time were recorded across the study (Appendix 3). Action descriptions and setting were continuously recorded during each focal follow. Each action performed by the focal child was recorded with a corresponding location, in which that action took place. Observations were subsequently coded into action descriptions according to the definitions given in Appendix 1. Reliability of coding was compared between independent observers. The percentage of agreement between independent coders was 87% ((number of agreed codes/total codes) x 100). For full details on methods, see Chapter II.

3.4.2 Behaviour Settings Survey

Behaviour setting surveys were conducted to verify setting independence between each indoor classroom and the shared outdoor yard, as well as each indoor setting from every other indoor setting. The outdoor environment and all classrooms passed the structural test:

a) Both adults and children had standing patterns of behaviour in the indoor and outdoor settings. Children engaged in play behaviour in both settings: engaging with materials, toys and each other during free play. Children also engaged in circle time, mealtime and naptime when indoors. Outdoors, children climbed on structures and ran through open spaces. Adults observed children in both settings. Indoors, adults engaged in activity, meal and nap preparation. Children and adults changed classrooms, left and joined the day care, but the standing patterns of behaviour did not change.

b) Day care behaviour was anchored to a particular milieu complex: the day care was set up to facilitate play behaviour. It was also set up for adult observing behaviour. Indoor and outdoor settings were open spaces with few structures blocking the view of any part of the space.

c) Patterns of behaviour occurred at a particular time-space loci: day care behaviour always occurred in the Building Blocks Day Care building. It always occurred at the same time: weekdays from 07:30 to 18:00.

d) Behaviour and milieu were synomorphic in that settings invited particular types of behaviour. Children responded to the outdoor play structures by climbing on them and the open space by running. Indoors, children manipulated the materials and toys.

e) Finally, the milieu was circumjacent to the behaviour. The milieu boundaries (the fence in the outdoor setting and the walls in the indoor setting) surrounded behaviour and the internal components of the milieu.

The interdependence index was then used to determine whether behaviour settings were independent. The interdependence score, or *k* score, is determined by totaling the scores of seven measures. Each measure is given a score from 1 to 7, where 1 is the most interdependent and 7 the most independent. For example, if Setting A and Setting B are simultaneously active, they would receive a score of 1 for temporal interdependence. In contrast, a score of 7 on the behaviour objects measure would mean that Setting A and Setting B do not share any objects in common. *K* scores can therefore range from 7 to 49. A score of 20 or lower indicates behaviour setting interdependence (not separate behaviour settings), and a score of 21 or higher indicates setting independence (separate behaviour settings). In other words, a score of 21 or higher is required for Setting A and Setting B to be considered different behaviour settings.

The first measure is behavioural interdependence. It measures the degree to which behaviour in Setting A influences Setting B. This includes actions begun in one setting and finished in another, or the physical resultants of Setting A spreading to Setting B, for example, an odor or vibration spreading across settings. The second measure, population interdependence, measures the degree to which individuals enter both settings. The third measure, leadership interdependence, measures the degree to which a leader in Setting A is also a leader in Setting B. The fourth measure, spatial interdependence, measures the degree to which Setting A and B share the same or proximate spaces. The fifth measure, temporal contiguity, measures the degree to which Setting A and B share the same or proximate times. The sixth measure, interdependence of behaviour objects, measures the degree to which settings share or have similar objects. Last, similarity of behaviour mechanisms measures the degree to which Setting A and B share the following behaviour mechanisms: gross motor action, manipulation, verbalization, singing, writing, observing, listening, thinking, eating, reading, emoting and tactile feeling.

Scores comparing indoor to outdoor settings are presented in Table 3.1. All indoors settings were independent from the outdoor setting. Measures were the same for each indoor-outdoor comparison. Scores comparing indoor settings are presented in Table 3.2. All indoor settings were independent of each other.

Table 3.1. Indoor-outdoor Interdependence Scores

Interdependence Measure	**Score**
Behavioural	7
Population	3
Leadership	3
Spatial	4
Temporal	1
Behaviour Object	6
Behaviour Mechanism	2
Total Score	26

Table 3.2. Indoor Interdependence Scores

	Score					
Interdependence Measure	Jr.1 – Jr.2	Jr.1 – Senior	Jr.1 – Kinder	Jr.2 – Senior	Jr.2 – Kinder	Senior - Kinder
Behavioural	7	7	7	7	7	7
Population	5	7	7	7	7	5
Leadership	3	4	4	4	4	3
Spatial	4	4	4	4	4	4

Temporal	1	1	1	1	1	1
Beh. Object	2	2	2	2	2	2
Beh. Mechanism	1	1	1	1	1	1
Total Score	23	26	26	26	26	23

3.4.3 Statistical Analysis

Multilevel models were run using the lme4 (Bates, Maechler, Bolker, & Walker, 2015) package in R version 3.2.3 (R Core Team, 2015). Two models were constructed: an object manipulation model and a motor model. In the object manipulation model, object manipulation rate was the response variable. Age group (ranked) and setting (indoor and outdoor) were included as main effects, with an interaction effect of age group and setting. Child ID was the random effect. In the motor model, motor rate was the response variable. As with the object manipulation model, age group (ranked) and setting (indoor and outdoor) were main effects, with an interaction between age group and setting. Child ID was entered as a random effect. Model assumptions were checked for normality. A square root transformation was applied to both dependent variables. I used $R^2_{marginal}$ values to assess fixed effects and $R^2_{conditional}$ values to estimate the effect of the full model. These were generated by the MuMIn package (Bartoń, 2016). Alpha was set at 0.05.

3.5 Results

3.5.1 Object Manipulation Rates

Indoor object manipulation rates are displayed in Figure 3.1, and outdoor rates are displayed in Figure 3.2.

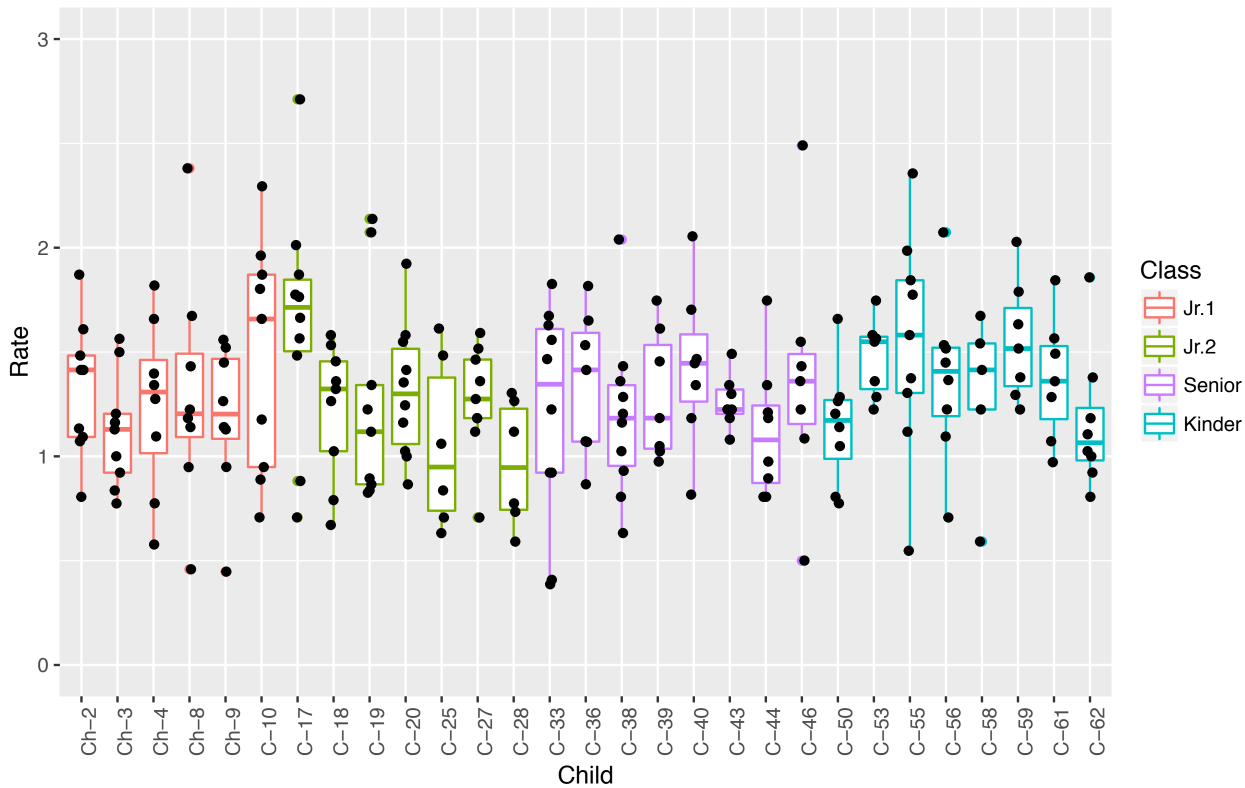

Figure 3.1. Indoor Object Manipulation Rates by Child

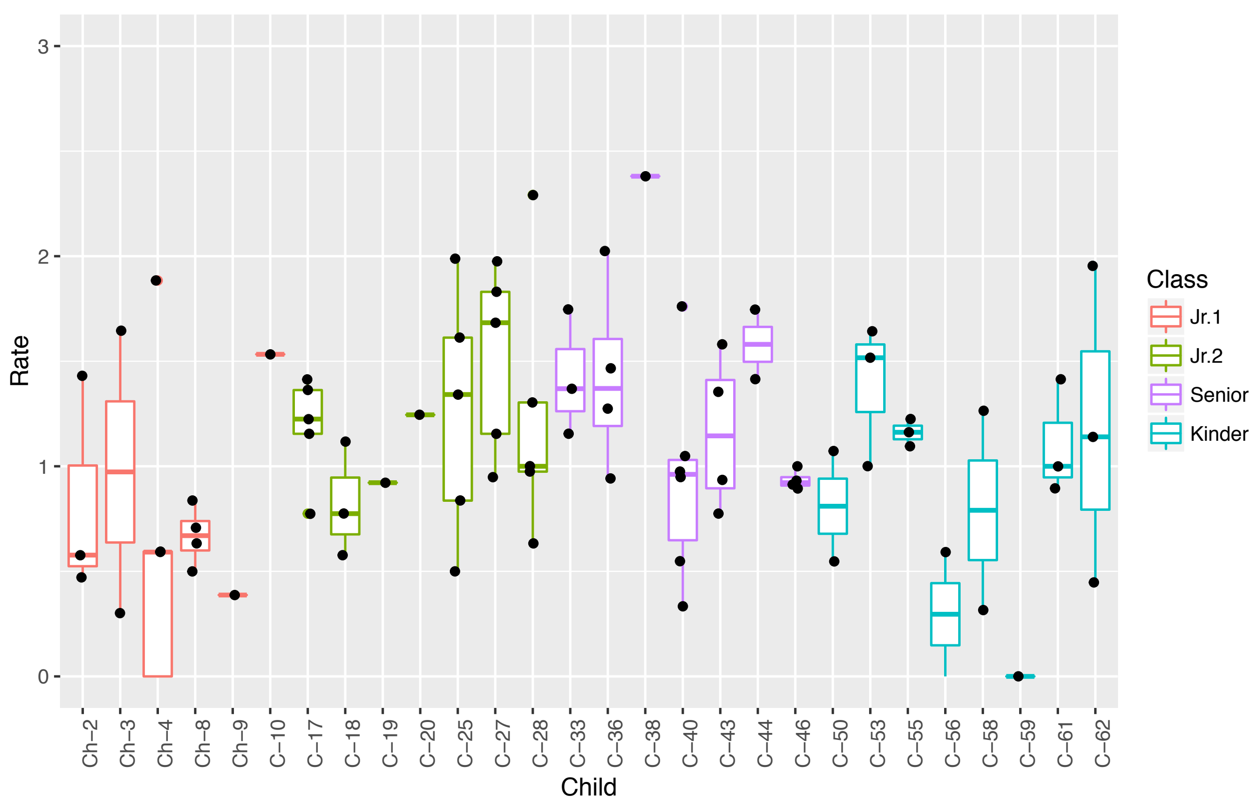

Figure 3.2. Outdoor Object Manipulation Rates by Child

Age group and setting did not have main effects on object manipulation rates, nor did an interaction term of age group by setting have an effect (Table 3.3). Object manipulation rates were similar across indoor and outdoor settings, as well as across indoor settings. All age groups engaged in similar rates of object manipulation in the shared outdoor setting. No interaction term effect indicates that age groups did not react differently to setting. The random effect of child did not account for variance beyond the variance explained by main effects ($R^2m = 0.0514$, $R^2c = 0.0554$). Therefore, not only were object manipulation rates similar across age groups, object manipulation rates were also similar across individual children.

Table 3.3. Object Manipulation Rate With Interaction Term

	Estimate	**Std. Error**	**t-value**	**p-value**
(Intercept)	1.231	0.075	16.461	<0.001
Age group	0.026	0.027	0.961	0.336
Setting (REF: Indoors)	-0.276	0.147	-1.875	0.061
Rank:Setting (REF: Indoors)	0.0224	0.053	0.421	0.674
Groups	**Variance**		**Std. Dev.**	
Child ID (Intercept)	0.0006		0.0258	
Residual	0.1943		0.4408	

Results refute the first prediction that object manipulation rates would differ across indoor and outdoor settings: rates remained the same across setting. Object manipulation rates also remained the same across age groups within settings. Therefore, results support the prediction that behaviour would be similar in the shared outdoor setting, regardless of age group, but refute the prediction that rates would differ between indoor settings due to age groups being segregated into different classrooms.

3.5.2 Motor Rates

Indoor motor rates are displayed in Figure 3.3, and outdoor motor rates are displayed in Figure 3.4.

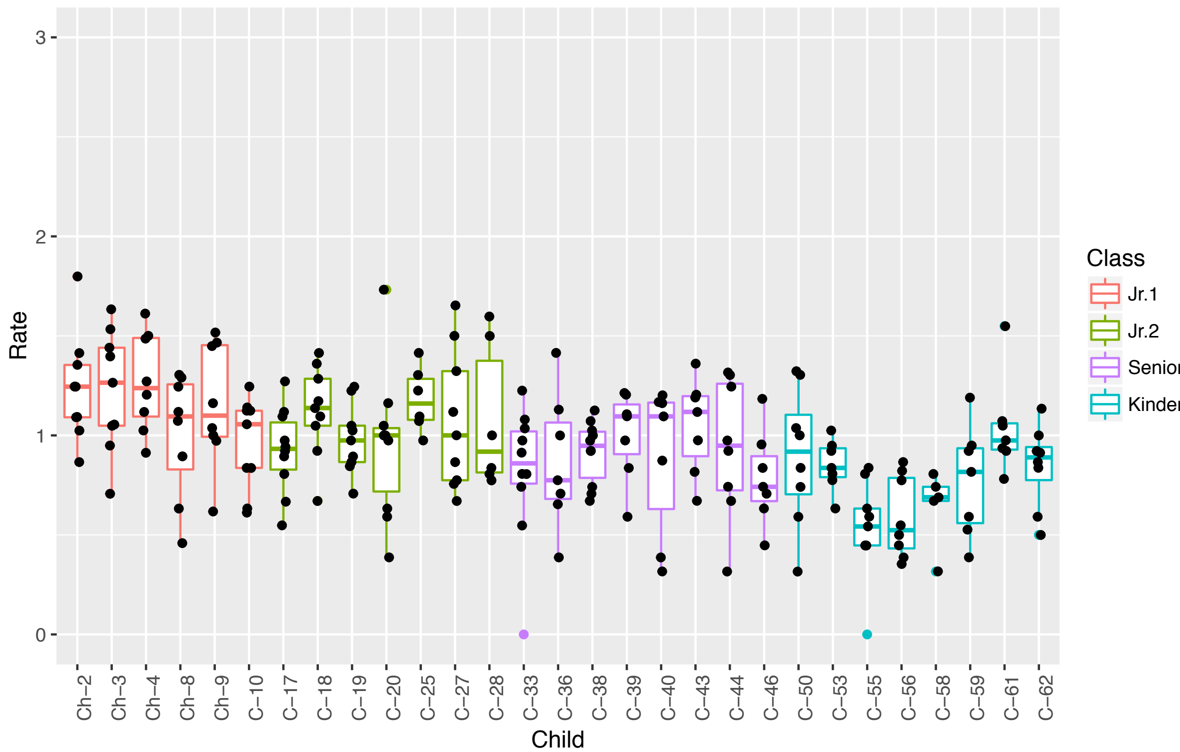

Figure 3.3. Indoor Motor Rates by Child

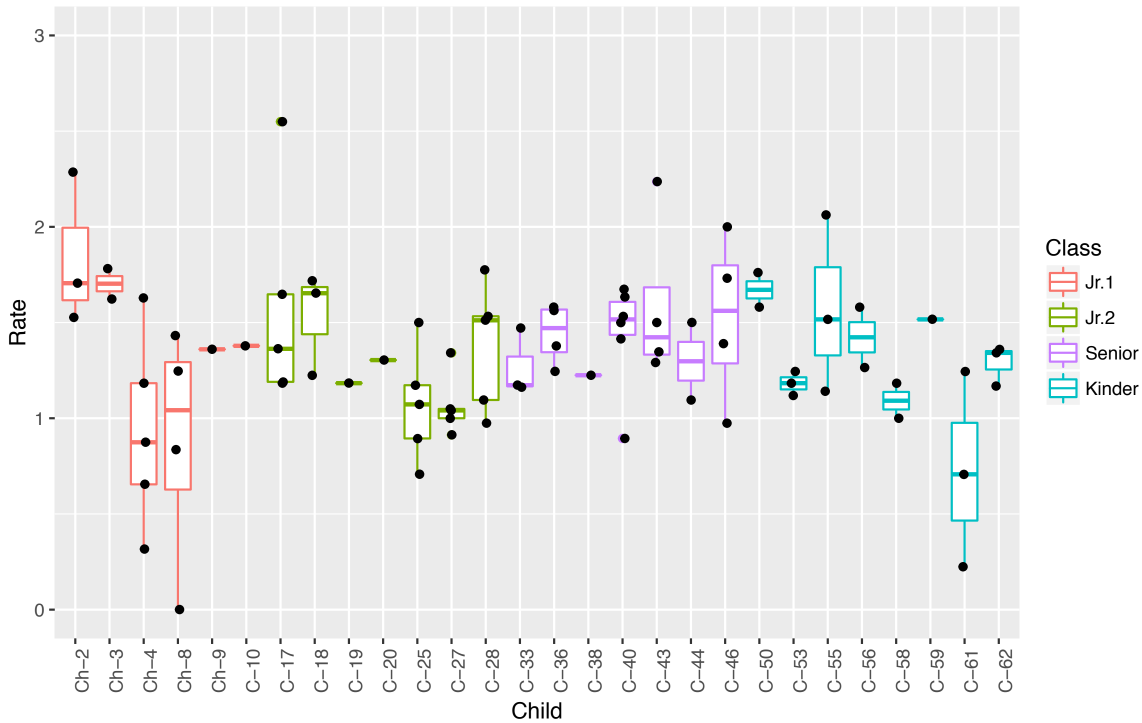

Figure 3.4. Outdoor Motor Rates by Child

In the motor rate model, there was strong evidence (t-value = -5.94; p-value = <0.001) for a main effect of age, with an average increase of 0.016 actions/minute when moving from indoors to outdoors, with a standard error of 0.000 (Table 3.4). There was no main effect of setting; however, there was strong evidence (t-value = 3.84; p-value = <0.001) for an interaction between age group and setting. Therefore, age groups reacted differently to setting.

Pairwise comparisons, using Sidak adjustments, were used to compare indoor and outdoor behaviour for each age group. These comparisons indicate that all age groups, expect Jr.1, showed significantly different motor rates between indoor and outdoor settings (Table 3.5). Pairwise comparisons were also used to compare behaviour between age groups within the outdoor setting (Table 3.6) and indoor settings (Table 3.7). None of the age groups differed in the outdoor setting. However, there were differences between the indoor settings. Age groups were not significantly different from age groups directly next to them in age, but were significantly different from age groups one or two age groups apart from them (e.g., Jr.1 motor rates were not significantly different from Jr.2 motor rates, but were significantly different from Senior and Kinder motor rates). The random effect of Child ID accounted for 2% of the variance beyond what was explained by the fixed effects (R^2_m = 0.28; R^2_c=.30).

Table 3.4. Motor Rate Model Fixed and Random Effects

	Estimate	**Std. Error**	**t-value**	**P-value**
(Intercept)	1.275	0.059	21.607	<0.001
Age Group	-0.125	0.021	-5.935	<0.001
Setting (REF: Indoors)	-0.011	0.107	-0.106	0.916
Age Group x Setting (REF: Indoors)	0.149	0.039	3.842	<0.001

Groups	**Variance**	**Std. Dev.**
Child ID (Intercept)	0.0028	0.0526
Residual	0.1013	0.3183

Table 3.5. Indoor-outdoor Pairwise Comparisons

Age group	**Contrast**	**Std. Err.**	**z-score**	**p-value**	**C.I.**
Jr.1	0.105	0.092	1.14	1.00	-0.187 – 0.397
Jr.2	0.267	0.077	3.49	0.017	0.023 – 0.511
Senior	0.535	0.077	6.93	<0.001	0.289 – 0.780
Kinder	0.508	0.084	6.05	<0.001	0.241 – 0.775

Table 3.6. Pairwise Comparisons Between Age Groups in the Outdoor Setting

Age Group Comparison	**Contrast**	**Std. Err.**	**z-score**	**p-value**	**C.I.**
Jr.1-Jr.2	0.058	0.107	0.54	1.00	-0.284 – 0.340

Jr.1-Senior	0.196	0.108	1.81	0.92	-0.148 – 0.540
Jr.1-Kinder	0.030	0.113	0.27	1.00	-0.328 – 0.390
Jr.2-Senior	0.138	0.096	1.43	1.00	-0.168 – 0.445
Jr.2-Kinder	-0.028	0.102	-0.27	1.00	-0.351 – 0.296
Senior-Kinder	-0.166	0.102	-1.62	-0.49	-0.491 – 0.160

Table 3.7. Pairwise Comparisons Between Age Groups in Indoor Settings

Age Group Comparison	**Contrast**	**Std. Err.**	**z-score**	**p-value**	**C.I.**
Jr.1-Jr.2	-0.105	0.069	-1.53	0.991	-0.322 – 0.113
Jr.1-Senior	-0.234	0.067	-3.48	0.018	-0.447 – (-0.019)
Jr.1-Kinder	-0.373	0.068	-5.48	<0.001	-0.589 – (-0.157)
Jr.2-Senior	-0.129	0.065	-2.00	0.808	-0.335 – 0.0767
Jr.2-Kinder	-0.268	0.066	-4.10	<0.001	-0.477 – (-0.599)
Senior-Kinder	-0.139	0.064	-2.17	0.656	-0.344 – 0.649

The motor rate model supports the first behaviour setting theory prediction that motor rates would differ across indoor and outdoor setting for all age groups other than Jr.1. In line with prediction, motor rates were similar across all age groups in the shared, outdoor setting. The prediction that motor rates would differ between age groups in the indoor setting was partially confirmed. Although not all age groups were significantly different from one another, there was an age trend, in which motor rates became increasingly different the further apart the age groups.

3.5.3 Physical Properties

Indoor differences between age groups may have been due to physical differences between classrooms. All classrooms are similar in that they are sectioned into play areas, using shelving and carpeting to differentiate space. The rooms differed in both area and layout, however. It is possible that motor differences between classrooms were a result of younger children having more space for movement. Area per child (Table 3.8) and longest path (Table 3.9) were included in a model to determine whether these variables had an affect on indoor motor rate. Area for each room was calculated as: (total area – furniture area)/average number of children in that room.

Table 3.8. Setting Area

Classroom	Area (square meter/child)
Jr.1	10.14
Jr.2	7.70
Senior	6.25
Kinder	4.55

Table 3.9. Longest Path

Classroom	Path (meter)
Jr. 1	7.26
Jr.2	11.86
Senior	9.50
Kinder	4.14

Indoor motor rates were set as the dependent variable. Age group (ranked), area and longest path were included in the model as fixed effects. Child ID was set as the random effect. There was no main effect of age group, area or longest path (Table 3.9). Therefore, the physical properties of area and longest path did not have an effect on motor rate. Unlike the previous motor rate model, age group did not have an effect on motor rate in the current analysis. This suggests the effect of age group on motor rate is not robust. Child ID did not account for variation above the variation accounted for by fix effects (R^2_m = 0.019; R^2_c = 0.019).

Table 3.9. Indoor Motor Rates With Physical Properties

	Estimate	**Std. Error**	**t-value**	**p-value**
(Intercept)	2.370	2.185	1.085	0.278
Age Group	-0.218	0.332	-0.657	0.511
Area	-0.086	0.173	-0.497	0.619
Longest Path	-0.010	0.016	-0.617	0.537

Groups	**Variance**	**Std. Dev.**
Child ID (Intercept)	0.0000	0.0000
Residual	0.1586	0.3983

3.6 Discussion

This research project tested motor and object manipulation rates across settings, based on predictions from behaviour setting theory. Some predictions were supported: motor rates changed between indoor and outdoor settings for most age groups (Jr.2, Senior and Kinder); motor rates were similar across age groups in the shared outdoor environment; indoor motor rates varied across some classrooms; and object manipulation rates were similar across age groups in the shared, outdoor environment. There were also predictions that were refuted, however: motor rates did not change across setting for Jr.1 children; indoor-outdoor object manipulation rates did not change for any age group; and indoor object manipulation rates did not vary across classrooms.

Similarities in object manipulation rate may have been due to similar object availability across settings. In the indoor settings, there were far more toys/materials available than children in the room; each child had unrestrained access to objects to manipulate. Additionally, toys and materials were similar across settings; therefore, each setting provided similar opportunities for action (Appendix 4 and 5). All classrooms had art materials, books, trains/cars, and toys for fantasy play and building. In the behaviour settings survey, each class comparison received a behaviour object score of 2 – a score indicated high interdependence.

There was also no difference in object manipulation rates across indoor and outdoor settings despite the outdoor setting having far fewer toys available per child than in the indoor settings, as well as less variety (Appendix 6). Object manipulation rates may have been similar, however, due to the outdoor environment providing natural materials, such as twigs, leaves, grass, rocks, pinecones and insects, which were not present indoors. During data collection, children engaged with these materials. For example, pulling leaves off trees and collecting pinecones and insects. Therefore, my initial assumption that the indoor environment provided more opportunities for object manipulation may have been incorrect. Future work may attempt to quantify natural elements in outdoor settings, for example, by measuring square footage of grassed, sanded or rocked areas or counting the number of trees.

Developmental factors are another possible cause of unexpected results. Behaviour settings theory is a general behavioural theory – it is not exclusively a developmental theory, and therefore, does not account for developmental differences. Intrinsic motivation due to developmental stage may have influenced Jr.1 motor rate similarities across settings. Their consistent motor rate was similar to the outdoor behaviour of other age groups: Jr.1 children maintained high motor rates across both settings. Younger children may engage in higher levels of motor activity, regardless of setting because motor skill is a developmental priority of young children.

Although intrinsic motivation is not accounted for in behaviour settings theory, ruling out influences of setting can help determine whether intrinsic motivation is the cause of unexpected results. Barker and Wright (1954) list eight forces on synomorphy, three of which are applicable to the day care environment and may explain Jr.1 motor behaviour. The forces on synomorphy are not included in the behaviour setting survey, but may be useful for explaining why results did not align with prediction. Furthermore, forces on synomorphy may be helpful for more accurately identifying independent behaviour settings, which in turn, will better predict behaviour.

First, physical forces are potential influences on behaviour in the day care setting. The physical structure of a behaviour setting encourages certain behaviours while limiting others. For example, the high school hallways in the Barker's Midwest field site, allowed for locomotion in certain directions. The narrowness of the hallways prevented playing circle games, and directed movement in straight paths up and down the hallway. The hallways also inhibited sitting and lying through the absence of chairs or ledges.

The influence of physical forces was addressed in this study by asking what physical classroom differences contributed to the different motor rates. Although all classrooms are sectioned into play areas, with areas defined by rugs and shelving placement, there were differences in layout. Therefore, area/child and longest path were included in an indoor motor rate model. These physical forces did not affect motor rate, however. Considering the vast physical differences between indoor and outdoor settings (small, sectioned space versus large, open space), the physical forces of area and longest path are unlikely influences on

Jr.1 motor rate: one would expect variable rather than similar motor rates based on these vast physical differences.

A second possible force is learning: knowing suitable behaviour for particular behaviours settings. Learning suitable behaviour results in conformity to the standing pattern of behaviour. It is possible that Jr.1 children have not learned that there are different expectations for indoor and outdoor behaviour. Indoor behaviour includes walking over running, and seated activities over movement activities. As children age, however, they become better acquainted with setting rules and conform to the expectations of indoor and outdoor behaviour.

The third possible force is social influence. Each class has two childcare workers overseeing the children. It is possible that adults caring for young children may be more lenient when children do not follow the rules of indoor behaviour. This social force may work in combination with learning, as adults recognize that young children have not learned indoor-outdoor behaviour rules. A limitation of this study was that adult behaviour was not recorded; therefore, it was not possible to determine whether adult social force influenced Jr.1 motor similarity across settings.

One possible way to separate setting and developmental influences on behaviour is through structured observation. A structured observation would involve observations in a day care environment where age groups, as well as, physical and social factors can be manipulated. Then, varying age groups (participating at separate times to avoid age group social influences) could be observed in identical physical and social conditions. Training childcare workers to engage with children in a particular way, as done in Smith and Connolly's (1980) study, would avoid exposure to different adult social influences. Such a study would create consistent conditions to pinpoint sources of behavioural variability. If setting influences are ruled out, then intrinsic motivation is a convincing cause of motor differences between age groups.

If results contrary to prediction are due to forces of setting, not developmental factors, it is likely that the behaviour settings survey did not accurately categorize settings. That is, settings in the day care should have been categorized as interdependent to reflect the similarities in behaviour. In this case, the behaviour settings survey must be adjusted to better categorize settings, which will lead to more accurate predictions of behaviour. One way that the behaviour settings survey may more accurately capture interdependence of settings is by adjusting the interdependence index to better account for affordances of behaviour. The behaviour and milieu are the source of synomorphy, and therefore, are likely the best predictors of behaviour. Yet, all measures in the interdependence index have equal weight, despite not all directly measuring behaviour. The behavioural interdependence, behaviour object and behaviour mechanism measures are gauges of synomorphy: they quantify behaviour or milieu. It is questionable, however, whether the remaining four measures are equally effective in explaining behaviour.

Spatial and temporal proximity measures are concerned with time and space overlap between two settings. Behaviour during the same time of day (for example, early morning meetings) will likely be more similar than behaviour at different times of the day (an early morning meeting versus an evening meeting). Also, settings close in physical proximity (offices that share a building) may behave more similarly than settings far apart (in-town head office versus out of town satellite office). It is questionable, however, whether spatial and temporal proximity would have as great an effect on behaviour as behaviour mechanisms or object measures. For example, an early morning prayer group and early morning children's play group may occur at the same time of day, but the synomorphs of each setting are very different: the prayer group synomorph elicits quiet, reflective behaviour, while the play group synomorph elicits rambunctious play behaviour. A play group in the morning and a play group in the evening are more likely to be similar than a prayer group and play group even if they are both in the morning. Therefore, adjusting the weight of interdependence measures, according to their degree of influence, will likely result in categorizing settings in a way that more accurately predicts behaviour.

The last two measures, population and leadership, are unexpected additions to the interdependence index based on Barker's claim that standing patterns of behaviour remain the same regardless of individuals in the setting: it should not matter whether leadership is the same in both settings or if the settings have a shared population. If Barker's claim that standing patterns of behaviour persist despite changes in individuals, shared population and leadership should not influence whether settings have similar behaviour. If this is the case, population and leadership measures should be removed from the interdependence index.

Although adjustments to the interdependence index may result in more accurate predictions of behaviour, there were both confirmed and refuted predictions in the current study. Therefore, re-categorization of behaviour settings may not be necessary; rather, behaviour setting comparisons may be on a continuum of similarity/difference. The interdependence index has a strict *k* cut off point – the point at which settings are identified as interdependent or independent. The 21 cut off point creates a fine line: one point of difference results in settings being considered interdependent or not. Settings that barely reach the cut off point and settings that receive a maximum score are both independent. It seems unlikely, however, that settings with a score of 21 and settings of a score of 49 are equally similar to one another. Therefore, it may be beneficial to create a scale of interdependence-independence rather than two strict, all-or-none categories.

The highest *k* score in the current study was 26, with some *k* scores just making the 21-mark at 23 points – these are far from the maximum score of 49. An interdependence-independence continuum may explain why results in the current study both contradicted and supported behaviour setting theory: the settings were not different enough to results in vast differences in behaviour. The degree of interdependence-independence may also influence effect size, which was quite small even for significant results in the current study. Future research comparing settings that have received scores across the *k* score spectrum would determine how the degree of difference affects behaviour differences and similarities.

Although not all predictions were confirmed, behaviour settings theory is useful for addressing behaviour in complex environments. Behaviour settings theory pioneered an ecological approach to human behaviour that provides a systematic way to catalogue the complex environments of everyday life. The fact that some results were against prediction is not entirely unexpected considering the complexity of natural environments, but there are adjustments that may lead to more accurate predictions. Developmental differences may need to be taken into account when applying behaviour settings theory to child development. Additionally, adjustments to the behaviour setting survey or incorporating a continuum of behavioural similarities and differences may lead to more accurate predictions of behaviour. Overall, behaviour setting theory provides a solid foundation for ecological research by systematically measuring setting and accounting for its influences on behaviour.

3.7 Conclusion

Behaviour settings theory was applied to preschool child behaviour at a free play day care. Using the behaviour settings survey, the outdoor environment and each classroom were identified as independent behaviour settings. Therefore, the predictions were: behaviour would vary when moving between indoor and outdoor settings, age groups would behave differently than one another when in their separate indoor classrooms, but similarly when in the shared, outdoor environment. Some predictions were confirmed, but there were also exceptions: object manipulation rates were the same across all indoor classrooms and across indoor and outdoor settings; and Jr.1 children did not change their motor behaviour across indoor and outdoor settings. These results suggest that there may be exceptions based on age, or the behaviour setting survey may need to be adjusted to more accurately predict behaviour.

CHAPTER IV: A NATURAL HISTORY OF REPETITION

4.1 Introduction

Montessori education is an alternative education program with a clearly defined method and strong theoretical basis. Based on naturalistic observations of children, Maria Montessori's educational method capitalized on her understanding of development. Montessori identified four developmental planes—birth to six years of age, six to twelve years, twelve to eighteen years, and eighteen years onward—with children's developmental needs differing according to their plane of development (Montessori, 1995). Although Montessori theorized on all developmental planes, she considered the first plane to be the most important. Children construct their intelligence – the basis for making meaningful connections between concepts and aspects of the world – during this period. The second half of the first plane (three to six years) is particularly important because children of this age were argued to be particularly susceptible to educational influence. As children are ultimately in charge of their own development, due to internal impulses guiding behaviour according to developmental needs, the educator's role is to support and protect children's development.

Characteristic features of Montessori education are children's freedom to move around their environment and choose their own work. Children's work refers to activities centred on sets of educational materials, each of which has a specific learning goal. The preschool Montessori environment includes materials divided into four main learning areas: practical life, sensorial, language and mathematics. Each area has a set of materials intended to be used in a particular order – each activity building on skills learned in the previous activity. The Montessori educator, referred to as a Montessori "guide", presents new work to a child when he or she is developmentally ready. Regular observations are part of the guide's role for supporting children's developmental needs; guides recognize the right time to present new work by observing the number of times a child repeats previously presented work, and his or her ability to successfully complete the work.

Children's work occurs during scheduled three-hour work periods, which are another defining feature of the Montessori environment. Montessori identified three hours as the ideal work period length, as this timeframe allowed children to reach their peak level of concentrated work (Montessori, 2007a). According to Montessori's charted observations of the three-hour work period, the period has two work phases. During the first phase, children engage with familiar work. This is followed by a period of "false fatigue", during which children appear restless and aimlessly walk around the room. After this short intermission, however, children settle into advanced, concentrated work, followed by rest. The Montessori guide protects the work period by prohibiting any interruption during the three hours.

4.1.1 Origins of the Method

Despite Montessori education often being considered an alternative to traditional schooling, Montessori education is not new. The first Casa dei Bambini, or Children's House, opened in 1906 (Standing, 1957). Maria Montessori, originally a physician but known for her work with disabled children, was asked to oversee the care of sixty children between the ages of three and six living in the San Lorenzo quarter – a slum in Rome. The children and their families had moved into a housing complex, built by the Institutio Romano dei Beni Stabili as a charitable endeavor. A space in the complex was set up to provide childcare while parents worked.

Montessori had been eager to work with typically-developing children since working with disabled children at the University of Rome Psychiatric Clinic ten years earlier.

Montessori had used educational materials developed by Eduard Séguin and Jean Itard to teach the children through hands-on experience. After seeing vast improvements in children thought incapable of learning, she wondered whether typically-developing children could excel with similar guidance. Consequently, Montessori accepted the position.

Montessori orchestrated the childcare centre from its inception, which is an important part of the Montessori origin story. The Montessori Children's House was not set up in typical fashion with rows of school desks facing the front of the classroom. Limited funds required classroom furniture to be claimed under the heading of "office furniture" by the housing complex, thus preventing Montessori from furnishing the room as a traditional classroom. Therefore, Montessori commissioned small tables and chairs to be made for the children, as these furniture pieces fit the office furniture requirement (Standing, 1957). As Montessori was not able to find a trained teacher, a "young, working-woman" was hired to care for the children (Montessori, 1966). Although she had once studied to become a teacher, she had given it up. Therefore, Montessori (1966) claimed that the young woman was not partial to any particular educational ideology.

The initial Children's House was set up differently than Montessori environments today. The room was plain and simply furnished. It was not "bright and cheerful," nor did it contain flowers, which became characteristic of Montessori schools (Montessori, 1966). There was a large table used as the teacher's desk and a large, locked cabinet that stored the materials. Descriptions of how the classroom was conducted are few. The teacher was instructed on how to demonstrate materials (similar to those used in the psychiatric clinic), but also included additional objects that she made herself, such as gold crosses that she gave out for good behaviour. It seems there was no formal structure to the original Children's House, unlike the structured, three-hour work schedule in Montessori environments today.

Montessori (2007b) attributed the development of her method to these original conditions. The first children's house had:

> "… a neutral atmosphere as far as any educational influence was concerned. The work of the school proceeded in a truly scientific fashion since it was not opposed by any obstacles. And this freedom from any hindrances contributed much to the happy outcome of the experiment. The Children's House was thus a kind of psychological laboratory, unharmed by any prejudices" (p. 40).

The origin story is told in Montessori's own written work (Montessori, 1966; Montessori, 2007b), biographers of her method (Standing, 1957), and in AMI training courses. It is described as a miraculous event, in which Maria Montessori is compared to Columbus, discovering a new world (Standing, 1957).

The claim that Maria Montessori was not impacted by external educational influences is unlikely, however. Montessori herself acknowledged the influence of Séguin and Itard on her work (Montessori, 2007b). As noted above, they supplied the basis of the Montessori materials, and introduced her to scientific education, which she described as an education capable of modifying pupils through close observation and adjustments of methods. It is also likely that other educational ideas, in addition to Séguin and Itard, influenced Montessori's educational theory, even though these influences are not mentioned.

Montessori was not the first educator to set up a classroom that allowed free-flowing movement instead of the restricted environment of early childcare settings, such as the English Infant Schools and French *salles d'asile*. Free movement was also a feature of Froebel's kindergarten, which Froebel introduced to Germany in 1840 (Thompson, Hogan, & Clark, 2012). Additionally, there are conceptual similarities between Froebel and

Montessori. In contrast to the commonly held view that education was a means to mold children, both Froebel and Montessori believed that children's inherent natures should be allowed to develop freely, with gentle adult guidance. Additionally, Froebel and Montessori believed that disturbances (Froebel), or deviations (Montessori), could disrupt children's natural state. For Froebel, the cure for these disturbances was to bring children into surroundings where they would recognize the negative consequences of their behaviour (Lilley, 1967). Similarly, Montessori theory states that deviations can be corrected by providing purposeful activities that allow children to re-connect with their environment.

There are, however, also important differences between Froebel and Montessori's theories, with the main difference being their views on work and play. In Montessori education, children's activities are described as "work." and taken extremely seriously. One of the main guidelines in the Montessori environment, for example, is not to disrupt a child's work. Children work to construct themselves: to organize their personality, develop their intelligence, and learn about their environment. In Montessori theory, work is characterized as an enjoyable activity and expression of humanity. Those who find work difficult and repugnant have therefore deviated from their natural state (Montessori, 1966). Accordingly, Montessori considered work and play to be distinctly different activities (Standing, 1957). Although she acknowledged play as an activity that satisfies one's nature, Montessori considered work more deeply satisfying as it develops one's whole being. Consequently, Montessori was greatly opposed to her method being referred to as "teaching through play." She believed that calling children's activities "play" ignored their natural ability and inclination to work.

Froebel, on the other hand, considered play the most important activity for development. According to Froebel, play contributes to development by harmoniously exercising physical, emotional and intellectual qualities. He considered it the purest of man's activities and typical of human life as a whole (Standing, 1957). Therefore, Froebel encouraged both guided play, through the use of prepared activities (Froebel's gifts), and free play.

Despite Froebel and Montessori's divergent views on play and work, there are more similarities than differences. It is possible that they developed their theories independently, but this seems unlikely. Froebel's ideas had spread throughout Europe by individuals dedicated to his work (Downs, 1978), and Froebelian theories had been introduced to Italy before Montessori's theory was developed. Froebel's first kindergarten was established in Italy fifty years before the first Children's House opened (Albisetti, 2009). Although, few fully Froebelian kindergartens had opened in Italy, Froebelian ideologies were incorporated into the Italian *asili*, the Italian equivalent to infant schools and *salles d'asile*. A survey commissioned by Minister Paolo Boselli in 1889 revealed that there was a range of educational theories incorporated in *asili*, and 10% of the *asili* were strongly Froebelian.

Discussing the possible influence of Froebelian theory on Montessori theory is not intended to discredit Montessori theory. Rather, it is to point out that the origin of Montessori theory is not as independent as it is often argued. Around the period that Montessori theory was developed, there were also other large shifts in educational theory. Waldorf education, another well-known educational theory that promotes an integrated intellectual, practical and artistic approach to development originated shortly after Montessori education. The period in which Montessori education developed, then, was clearly one in which people were receptive to educational transformation, and an era when child-centred education flourished.

4.1.2 Observations and Discoveries

The original Montessori environment was adjusted in response to Montessori's observations of child behaviour. For example, the materials were originally shut away in a cabinet and disseminated by the teacher (Montessori, 1966). One day, however, when the teacher was late to arrive after forgetting to lock the cupboard, she found the children had helped themselves to the materials and were quietly working. While the teacher viewed this as theft and disobedience, Montessori interpreted the incident as meaning that the children knew the materials so well that they could make their own choices on what materials they engaged with. Consequently, "freedom of choice" was included as a concept in Montessori education.

Montessori continued to observe behaviours that were not typically attributed to children, each with a story similar to the discovery of "freedom of choice." These behaviours included discipline, love of work, love of silence, indifference to punishment and reward, sense of dignity, love of order, and a tendency to repeat activities. These behaviours are regarded as natural tendencies in all children, and therefore, have become fundamental concepts in Montessori education.

The natural tendency for repetition is of particular interest in the current study, which is interested in how children learn about the world through action. Love of work is also a natural tendency that involves action on the world. The concept of work, however, is a definition issue rather than one for empirical testing. Although adults often dichotomize work and play, exclusive categories may not exist for children. Two and three year olds are known for their eagerness to help their parents with chores. Whether driven by curiousity, wanting to be part of adult activities or simply for the enjoyment of activity, young children have not created the dichotomy between work and play that appears in adulthood.

There are many well-documented instances of children blending play and work. Lancy (2008) provides many cultural examples of children, who are required to contribute to the household economy, incorporating play into their work. In southern Uganda, girls engaged in child-minding play tag, but tagging someone requires touching your baby to their baby; young Kipsigis herders play tag among their flocks; and Hadza children, who forage their own food, forage in the spirit of fun and enjoyment. Some consider the concept of separated work and play absent in non-industrialized cultures, and that the division is characteristic of industrialized societies (Lancy, 2008). Therefore, there may be little difference between the "work" of a Montessori student and the "play" of a kindergartener; the only difference may be what the activity is called by adults. For this reason, I will focus on repetitive action.

4.1.3 Repetition

Repetition is one of the first natural tendencies that Montessori observed in the Sans Lorenzo Children's House. The classic story of repetition is of a three-year-old girl working with the so-called "cylinder block" (a wooden block with cylinder cutouts of varying dimensions) (Montessori, 1966). The girl caught Montessori's attention because of her intensity and concentration while repeating the activity. The repetitions persisted even while Montessori attempted to distract her from the task. She elicited other children's help in trying to distract the girl by having them sing and dance around her. When this did not break her concentration, Montessori lifted the child in her chair, and set her on top of a table. As

Montessori lifted her, however, she clutched the cylinders, and continued the activity, working with the cylinders on her knees. By the time the girl had finished, Montessori had counted forty-two repetitions.

Montessori then began to notice similar events occurring. Although the level of concentration that made children oblivious to their surroundings was not frequent, Montessori (1966) noticed that repetition of activities was “common to all and nearly constant in all their actions” (p.120). It became apparent to Montessori that children were not performing activities to reach an external goal. When Montessori showed the children how to wash their hands, they continued to wash their hands long after they were already clean. Montessori concluded that repetitive behaviour was the result of powerful and irresistible internal impulses fulfilling a profound psychological need (Standing, 1957).

Repetition is therefore an important part of day-to-day functioning in the Montessori classroom. Children are free to choose their work, but they must choose from the work that the Montessori guide has presented to them. As already noted, the guide does not present new work until the child is “ready,” with one criterion for this being that the child must repeat previous work before moving on. There is no hard and fast rule on the required number of repetitions; it is at the guide’s discretion. Therefore, guides also make judgments on readiness to move on to the next set of work based on the goals of each activity. For example, the goal for the bow-dressing frame is to learn how to tie bows, with the greater purpose of self-care. When the guide sees that a child has repeated the bow-dressing frame often enough to competently tie bows, the guide will show them the next work in the series: the lacing frame.

Understanding the nature of repetitive behaviour is important because it is used to determine a child's readiness to move on to the next activity. Therefore, gauging readiness by repetition affects opportunities for learning. Opportunities to engage in new work are limited if guides wait for children to repeat old work. This is not problematic if repetition is an effective tool for learning. However, if repetition has little affect on learning, or if repetition is used inappropriately, forcing children to engage in the same activities repeatedly may lead to stagnation.

Therefore, it is necessary to understand the role of repetitive behaviour in learning and development. The literature on repetition, however, is limited. Repetition is often associated with pathology, particularly autism spectrum disorder (ASD). Repetitive behaviour is a classification category for autism in the Diagnostic and Statistical Manual for Mental Disorders IV (DSM-IV) (Honey, Leekam, Turner, & McConachie, 2007). Repetitive behaviour includes a broad range of behaviour including sameness, rigidity and repetitiveness. Not only is repetition used as diagnostic criteria, but also, the frequency of repetition is an indicator of autistic severity.

Nevertheless, there is some research on repetition as non-pathological behaviour. Repetitive motor behaviour was recognized as a typical developmental behaviour by early developmentalists, such as Gesell (Gesell & Amatruda, 1941) and Piaget (1952). Esther Thelen, however, was one of the first to present a natural history of repetitive movement during the first year of life. Thelen identified forty-seven patterns, which involved movement in the legs, feet, arms, hands, fingers, head and torso (Thelen, 1979). These movements were highly stereotyped, and therefore, easily identifiable. Furthermore, the types of motor repetition had characteristic ages of onset, peak performance and decline.

Looking at motor developmental trajectories, repetitive behaviour in a particular muscle group preceded more complex motor behaviour of the same muscle group. For example, finger flexion preceded ability to grasp and hands-and-knees rocking proceeded crawling. Thelen (1979) proposed that repetitive motor behaviour was due to immature neuromuscular pathway, which would give rise to organized, goal-oriented behaviour once the appropriate motor pathways matured.

Later in Thelen's career, she became less focused on neurological explanations, instead using dynamical systems theory to explain developmental change. Instead of action being exclusively the result of neurological input, action is viewed as the result of multiple, overlapping influences (Thelen, 2000). In particular, Thelen has used this framework to study perseverate reaching, where eight to ten months old continually reach in the wrong place for a desired toy despite seeing where the toy was hidden (Smith & Thelen, 2003). Smith and Thelen's (2003) explanation counters Piaget's suggestion that infants fail at the task because they do not know that objects exist independently of their own actions, i.e., they possess an object concept. Instead, perseverate reaching is argued to be the result of the embodied memory of previous actions overriding the visual stimuli of seeing the toy in the new location. Thelen and Smith (2003) show that changing the infant's position from sitting to standing causes the error to disappear, which is hard to account for in cognivist Piagetian terms, but makes sense if one understands that changing position changes the entire dynamics of the baby's reaching system, which allows new behaviours to form.

Other examples of repetitive behaviour in infancy also suggest that self-induced repetition influences development. Infant babbling is repetitive verbal behaviour that leads to speech development. Infants learn about speech sounds not only by hearing them, but also by practicing them (Eliot, 1999). Babbling is a way for infants to exercise the muscles involved in speech, and increase the complexity of the sounds they are able to make. Babies begin with cooing at two months of age. Around five months of age, they add consonants to their speech production, with /b/, /d/, /m/, /n/, /w/, and /j/ being common. At ten months, infants create long repetitive strings of consonant and vowel sounds, such as babababa or mamama. Lastly, variegated babbling occurs in the second year, when syllables are mixed and intonated.

Little research on repetitive behaviour is found on typically developing preschool-aged children. Evans et al. (1997) note that Arnold Gesell observed compulsive-like behaviour in typically developing 2 ½ to 3 year olds. His observations of compulsive-like behaviour included repetition, ritualized behaviour, rigidity in terms of likes and dislikes, acute sensory awareness of minute details and strong preferences for sameness in the environment. Gesell's observations are in agreement with the observations made by Montessori, not only in terms of repetition, but also in children's desire of order and awareness of minute details.

Evans et al. (1997) also note that these behaviours are similar to behaviour described in psychopathology, such as repetitive checking, organizing objects or performing tasks in a way that is "just right." Evans et al. (1997) conducted a survey, asking parents about their children's compulsive-like behaviour. Factor analysis identified two principal components. The first component, or the "Just Right" factor, featured questions about their children's "Just Right" behaviours. This included survey questions on children's tendencies to carry out behaviours in certain ways, such as arranging objects. The second principal component, or the repetitive factor, included questions that asked about repetitive behaviour and insistence on sameness, such as: does your child act out the same thing over and over in pretend play? Or, does your child repeat certain actions over and over again? The repetitive factor not only included repetition, however, but also questions about children's insistence on sameness, such as: does your child prefer the same household schedule or routine every day? Therefore, analysis of the second component does not exclusively tell us about back-to-back repetitive action.

Results from the survey do indicate, however, that parents observed compulsive-like behaviour in their children. Peak performance of compulsive-like behaviour, including both repetitive behaviour and just right behaviour, occurred between twelve to forty-seven months. This differs from instances of pathological repetition, which is consistent across ages (Mooney, Gray, & Tonge, 2005). The survey conducted by Evans et al. (1997) thus provides a starting point for understanding repetition as a developmentally-typical behaviour. It also provides target ages, indicating when repetitive behaviour is at its peak.

4.1.4 Scientific Foundations of Montessori Education

Taking a scientific approach to explain concepts in Montessori theory and education is not novel. Montessori practitioners and proponents promote Montessori education as scientific, claiming it was developed through keen observation and experimentation. Montessori programs (Montessori School of Calgary, 2016) and book covers from Montessori publishing houses (Montessori, 1966) reference the scientific origins of Montessori education. There is also a desire to further legitimize Montessori education through scientific research: Montessori information videos note that Montessori methods are supported by scientific findings in neuroscience (Davidson Films, 2011); *Montessori: The Science Behind the Genius* (Lillard, 2007) is a book detailing the Montessori methods in line with scientific understanding of learning and development; research is also conducted comparing learning outcomes in Montessori education to other programs (Lillard, A.S., 2012).

The fixation on scientific justification may arise from Montessori herself referring to scientific methods in the development of Montessori education. In a chapter titled "My Contribution to Experimental Science" in *The Montessori Method – I*, Montessori discusses how she identified developmentally-appropriate materials scientifically (Montessori, 2007a). Montessori systematically presented children with variations of educational materials. For example, before settling on the final form and colour of the geometric solids (materials now part of the sensorial area), Montessori presented children with geometric shapes differing in size and colour. Since Montessori believed that children's internal nature guide their behaviour according to developmental needs, the size and colour variation that most attracted the children's attention were included as a permanent set of Montessori materials. Attraction was determined by measuring child engagement, specifically "polarization of the exercise" (extended concentration) and "repetition of the exercise." Montessori did not include detailed descriptions of her methods, but this not unusual for the time. Methodological detail was also sparse in Piaget's work (Bond & Tryphon, 2009). Although Montessori did not include precise scientific procedures, she described it as "long, systematic toil" (Montessori, 2007a).

Like Montessori's experimental work, there is little evidence to support Montessori's observational work, which provides the basis for Montessori theory – particularly the theory of natural tendencies. In Montessori's published work (Montessori, 1966) and work written by her followers (Standing, 1957), the natural tendencies that she observed are described only through anecdote. Personal correspondence with the archivist at Association Montessori Internationale (an organization started by Montessori to preserve the integrity of the method) revealed that data collected from observational studies are not known to exist. Therefore, the scientific origins of Montessori's theories are questionable.

4.1.4 Why Care About Montessori Education?

Montessori education is relevant to the current study because of Montessori's claim that naturalistic observations were used to understand child development and inform her educational theory. Although this is widely accepted, Montessori's work must also be empirically tested, as justifications for her findings are largely anecdotal. Therefore, it is possible that Montessori's claims are not general rules of behavioural development but may only apply to the particular children under her care. The need for empirical data is particularly pressing because Montessori practitioners and proponents alike claim that Montessori education is scientifically based. To make this claim, empirical evidence must be provided.

Another reason to empirically test Montessori's claims is that naturalistic observational research is more advanced now than during the time Montessori was working on her method. Methods for describing and recording behaviour have been improving since the 1960s through the work of the original ethologists (Smith & Connolly, 1980). Using such techniques may thus provide more accurate information about development than Montessori was able to collect through her own observational methods.

Additionally, it is important to study repetition in regard to its practical uses within the Montessori environment. Children in the Montessori environment are expected to repeat work before the Montessori guide will demonstrate another activity. Yet, little information about repetition is provided in Montessori's work. Therefore, it is difficult for Montessori guides, particularly new guides with little experience, to know what constitutes as repetition, particularly repetition that aids learning. Before uncovering the educational benefits of repetition, however, basic information about repetitive activity must be provided. Therefore, the aim of this study is to collect baseline information about repetition to empirically test Montessori's claims about repetition.

4.2 Research Aims

The aim of my study is to record a natural history of repetitive behaviour in preschool-aged children. Although non-pathological repetitive behaviour has been well researched, little is known about this behaviour in preschool-aged children beyond the peak ages identified in Evans et al. (1997)'s survey. Even in Montessori educational theory, where repetition is a central part of Montessori theory and daily practice, little information is provided beyond anecdotal accounts.

Self-induced repetition may have learning and developmental benefits. This is the supposition made by Montessori theory and suggested by infant research involving repetitive motor movement and babbling. The benefits of preschool-aged repetitive action cannot be assessed, however, until baseline information about repetition has been established. Therefore, the current project will present a natural history of repetition to describe its occurrence in a day care setting. Commonality of repetition across children and events, repetition bout length and ages most likely to engage in repetition will be presented and compared to Montessori's claims about repetition. A detailed record of repetitive behaviour is the necessary first step to uncovering the developmental benefits of repetition.

4.3 Research Predictions

Montessori proposed repetition was a natural tendency. Therefore, repetition should not be exclusive to a Montessori environment, but also be present in a free play day care environment. Specifically, I predict that, in accordance with Montessori's observations, (i) repetition will not be limited to one type of activity and (ii) all children will engage in repetitive activity. In agreement with Montessori's anecdotal account of repetition and Evans et al.'s (1997) study, I predict that (iii) children in the study group between thirty-three and forty-seven months old will engage in higher frequencies of repetition than older children. Finally, I predict that (iv) children will engage in long bouts of repetition as described by Montessori.

4.4 Methods

4.4.1 Data Collection

Data collection took place between April 27th, 2015 to June 18th, 2015 at a free-play day care in a mid-sized Northern Albertan city in Canada. Naturalistic observations were recorded for thirty-one children, who ranged in age from 33 to 72 months (mean = 50.94, S.D. = 11.56). Each child was assigned to a particular classroom, where membership was based on age. Children in the Jr.1 room ranged from 33 to 40 months; children in Jr.2 were 41 to 49 months; children in the senior room were 50 to 60 months; and children in the Kinder room ranged from 61 to 72 months. Two children (Child-6 and Child-30) unexpectedly changed classes during the study period and were excluded from analysis.

Each child was observed during twenty-minute focal follows (mean duration = 15.69 per child). The focal was paused if focal child left the room, and resumed when they re-entered. If the child did not return within ten minutes, a new focal on a different child would begin. In total, 101 hours of total observation time were recorded across the study (Appendix 3).

Action descriptions and location were continuously recorded during each focal follow. That is, each action performed by the focal child was recorded along with the location where the action took place. Observations were subsequently coded into action descriptions according to the definitions given in Appendix 1. Reliability of coding was compared between independent coders. The percentage of agreement between independent coders was found to be 87% ((number of agreed codes/total codes) x 100). Event codes, which included animation (ANI), construction (CON), fantasy play (FPL), rough-and-tumble play (RTP), traveling (TRA) and none (NON), were coded based on action descriptions: events were broad categories of behaviour that were made up of individual actions (Appendix 2). Inter-observer reliability was 89% ((number of agreed event codes/total event codes) x 100). For full details on methods, see Chapter II.

4.4.2 Repetition Coding

Repetitions were extracted from the data using a VBA macro in Microsoft Excel (see Appendix 5). Repetitions were recorded when object manipulation and motor action codes (i.e. not observation or social action codes) repeated within two actions of each other. The sequence of repeated actions was considered a repetitive bout. Three or more non-repetition actions were considered an interruption to the repetitive sequence and ended the bout. The macro output was vetted to ensure the recorded repetitions met repetition criteria. Repetition criteria were broad since Montessori did not specify the type of behaviours that counted as repetition. Therefore, all repetitive motor and object manipulation actions were included, except actions that are necessary for moving and engaging with objects: walks, runs, pick ups and put downs. Postural repetitions were also excluded since they are repositioning actions rather than actions likely to assist learning.

4.4.3 Statistical Analysis

Multilevel models were run using the lme4 (Bates, Maechler, Bolker, & Walker, 2015) package in R version 3.2.3 (R Core Team, 2015). Two models were constructed: a number of repetitive bouts per focal follow model and a bout length model. Multilevel Poisson regressions were run for both models because dependent variables were measured in counts. In the number of repetitive bouts model, number of repetitive bouts was the dependent variable. Age, focal follow length, repetition type and setting were fixed effects, with an interaction effect of repetition type and setting. Focal follow nested in Child ID was the random variable. In the bout length model, bout length was the dependent variable. Age, focal follow length, repetition type and setting were fixed effects. An interaction effect between repetition type and setting was also included in the model. Focal follow nested in Child ID was set as the random effect. Poisson model assumptions were checked using the DHARMa package in R (Hartig, 2016). Observation-level random effects were used in the first model to account for overdispersion in the data (Harrison, 2014). I used $R^2_{marginal}$ values to assess fixed effects and $R^2_{conditional}$ values to estimate the effect of the full model. These were generated by the MuMIn package (Bartoń, 2016). Alpha was set at 0.05. Descriptive analyses of summarized data were used to assess the commonality of repetition across children and events.

4.5 Results

4.5.1 Repetition During Events

Figure 4.1 displays the frequency of each event. Figure 4.2 displays the number of repetitions that occurred during each event. Travel (TRA) was not included because traveling indicated moving between play centres. Therefore, it was not an event during which repetition could occur. Combinations of events occurred in the data, but they occurred so rarely, they were not included (Table 4.1).

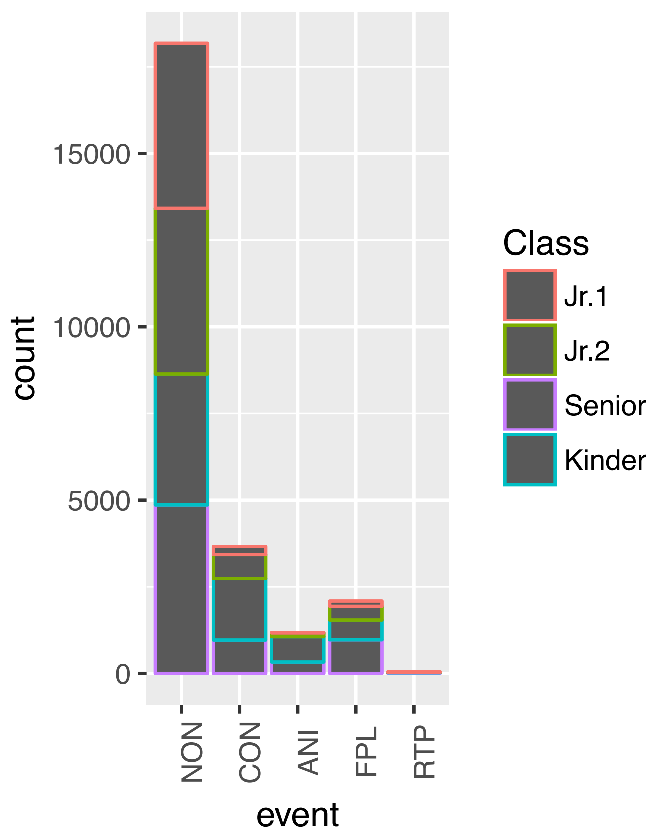

Figure 4.1. Total Action Counts by Event

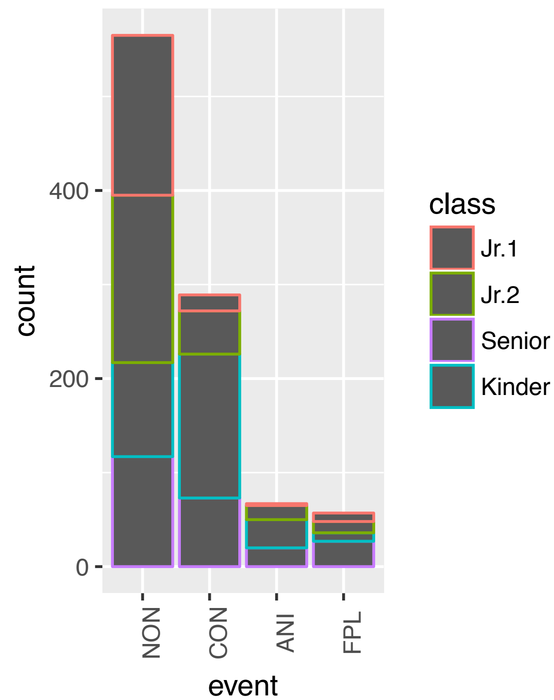

Figure 4.2. Repetition Number Count by Event

Table 4.1. Combination Events

Combination	**Number of Occurrences** (out of 27,368 actions)
Construction + Fantasy Play	6
Construction + Animation	29

I predicted that repetition would not be limited to one type of activity. Events were play activities that children engaged in throughout the day, and were used to verify or refute this prediction. Rough-and-tumble play was the only event in which repetition did not occur. This is expected as rough-and-tumble play is a social event. Since this study looked specifically at motor and object manipulation repetitions, repeated social actions were not recorded. Therefore, along with prediction, repetition occurred during all events in which object manipulation and motor actions occur.

4.5.2 Repetition Across Children

Figure 4.3 displays the total number of repetitions (motor and object manipulation repetitions) per focal follow by child. Figure 4.4 displays number of motor repetitions by child. Figure 4.5 displays the number of object manipulation repetitions by child.

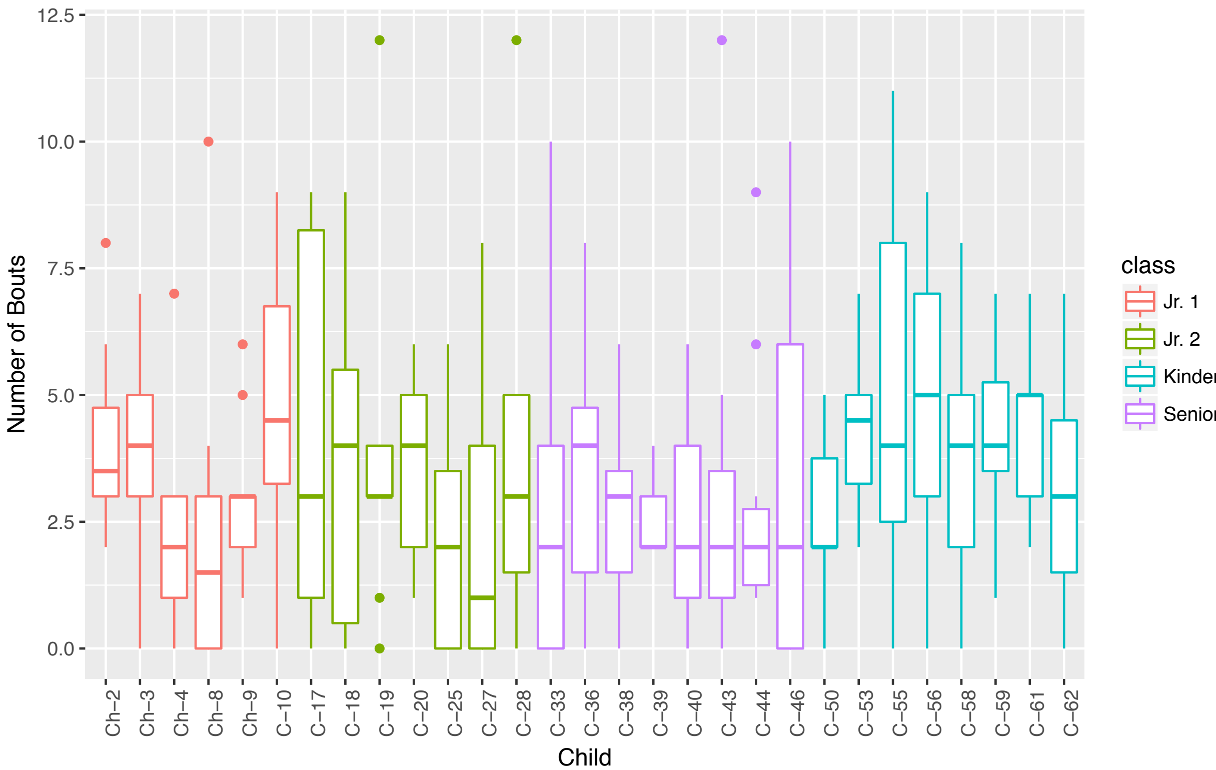

Figure 4.3 Number of Motor and Object Manipulation Bouts per Focal Follow

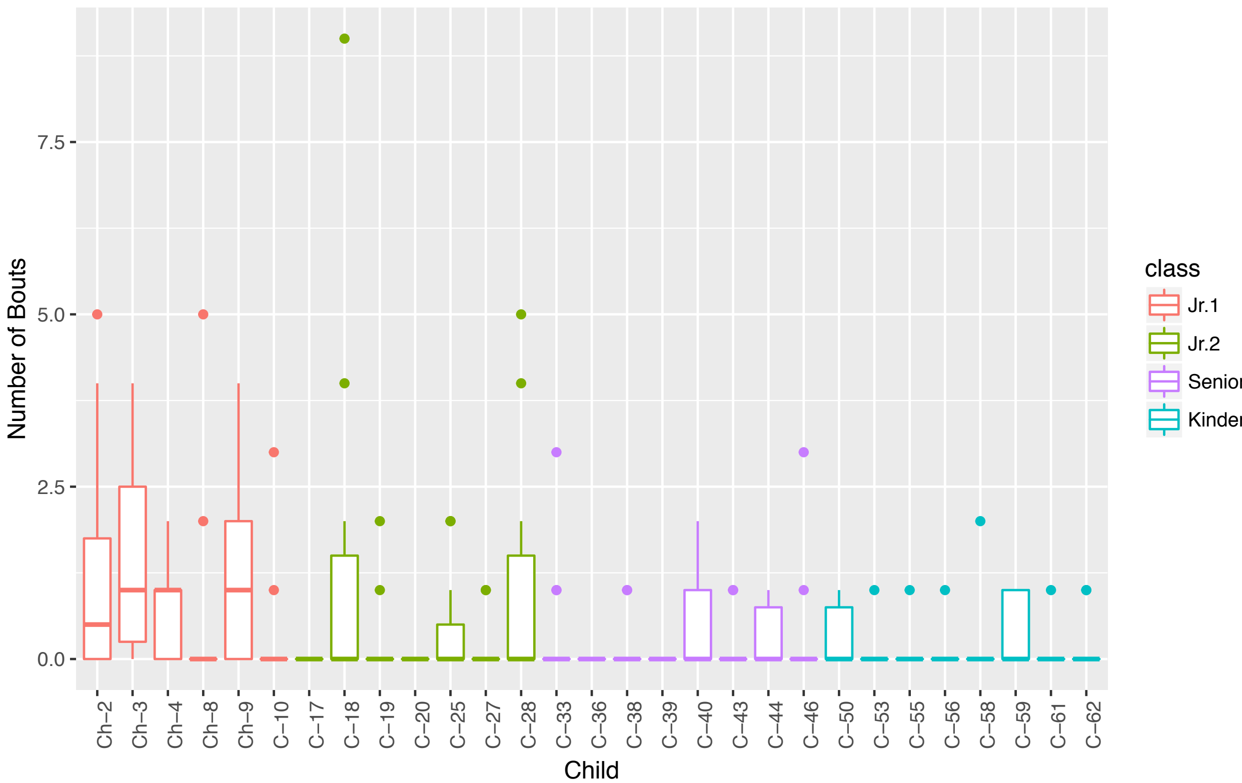

Figure 4.4. Number of Motor Bouts by Child

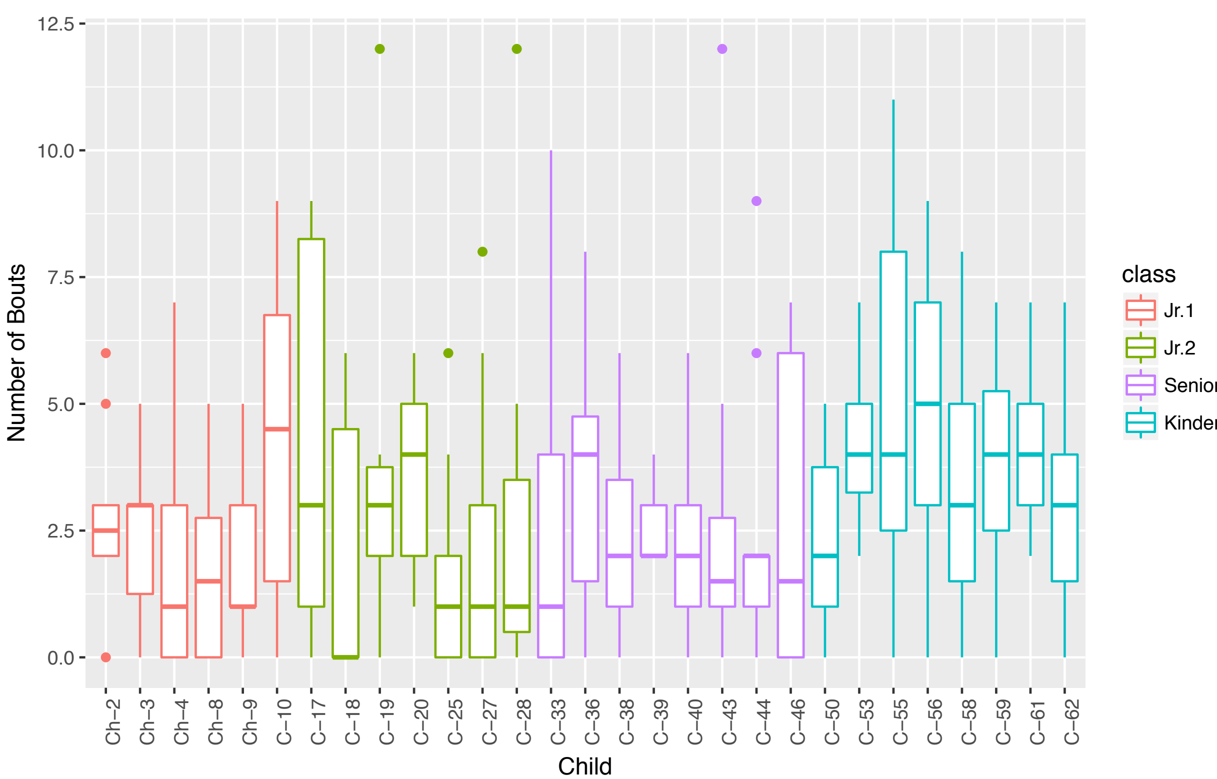

Figure 4.5. Number of Object Manipulation Bouts by Child

As predicted, all children engaged in repetition (Figure 4.3). Not all children engaged in both types of repetition. Four children (Child-17, Child-20, Child-36 and Child-39) did not engage in any motor repetition (Figure 4.4). All children engaged in object manipulation repetition, however (Figure 4.5), which is the type of repetition described by Montessori.

4.5.3 Repetition Age

Figure 4.3 displays the number of motor and object manipulation bouts per focal follow by child. There is variation across children; however, there does not appear to be an age trend. Specifically, younger children do not appear to engage in higher frequencies of repetition than older children.

Statistical analysis showed no effect of age (Table 4.2). However, there was strong evidence for a main effect of focal follow length and repetition type on number of repetitions. Additionally, there was moderate evidence for an effect of setting and an interaction effect of repetition type and setting. For the effect of focal follow length, longer focal follows had higher numbers of repetition (z-score = 5.99; p-value = <0.001). Object manipulation repetitions occurred significantly more than motor repetitions (z-value = 16.118; p-value = <0.001). The main effect of setting indicates that repetitions were more likely to occur outdoors than indoors (z-value = 2.17; p-value = 0.03). An interaction between setting and repetition type, however, indicates that repetition type differed by setting (z-value = -2.94; p-value = 0.003). An interaction plot displays the change in number of repetitive bouts based on setting (Figure 4.6). Motor repetitions increased when moving from indoors to outdoors. Object manipulation repetitions decreased when moving from indoors to outdoors. The shallow slopes and large error bars, however, indicate that the interaction effect is small. Focal follow nested in Child ID did not account for any variance beyond the variance accounted for by the main effects (R^2_m = 0.44; R^2_c = 0.44).

Table 4.2. Number of Repetitive Bouts Fixed and Random Effects

Fixed Effects	**Estimate**	**Std. Error**	**z-value**	**p-value**
(Intercept)	-1.374	0.136	-10.075	<0.001
Age	-0.027	0.052	-0.522	0.602
Focal Follow Length	0.312	0.052	6.058	<0.001
Rep. Type (REF: motor)	2.199	0.145	15.191	<0.001
Setting (REF: indoor)	0.501	0.231	2.171	0.030
Rep. Type * Setting	-0.796	0.270	-2.942	0.003
Random Effects	**Variance**	**Std. Dev.**		
Nobs	0.6256	0.7909		
Focal ID: Child ID	0.0000	0.0000		

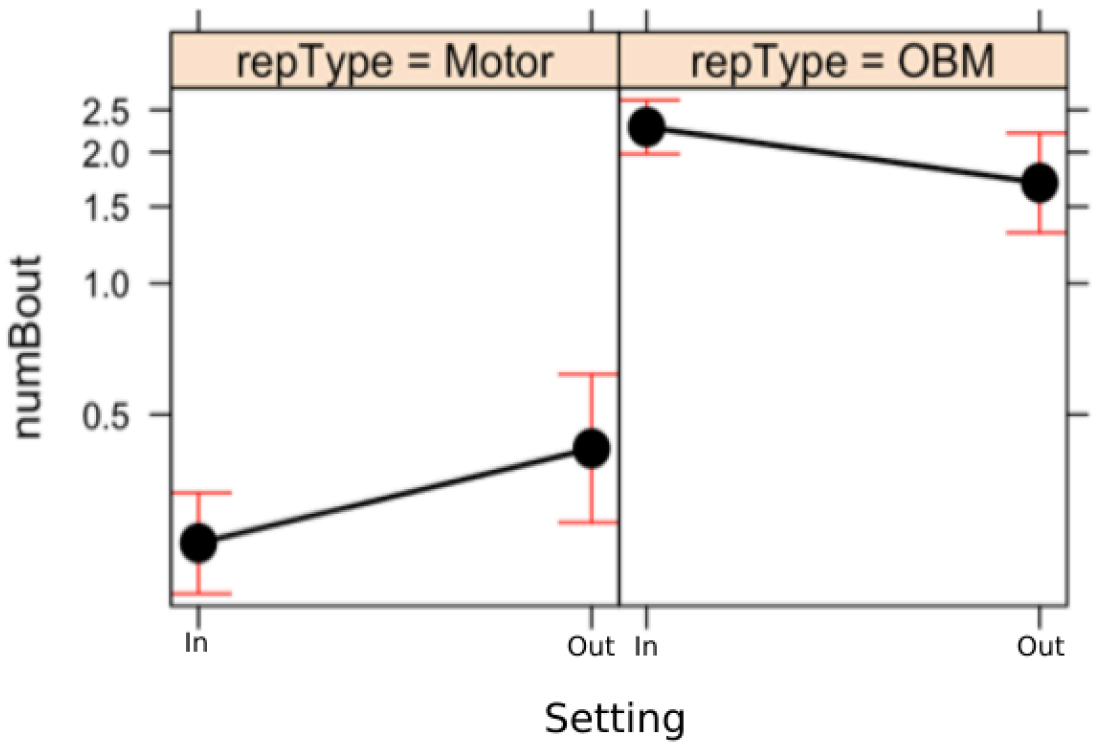

Figure 4.6. Setting and Repetition Type Interaction for Repetition Number

The results of this analysis refute the research prediction that younger children would engage in more repetition than older children. According to the model, there was no effect of age. Additionally, there was no random effect of child ID: there was no individual variation across children.

4.5.4 Repetition Length

Repetition bouts ranged from 2 to 19 in length, with an average length of 2.86. Figure 4.7 displays the distribution of repetitive bout length. Figure 4.8 displays the distribution of bout length by child.

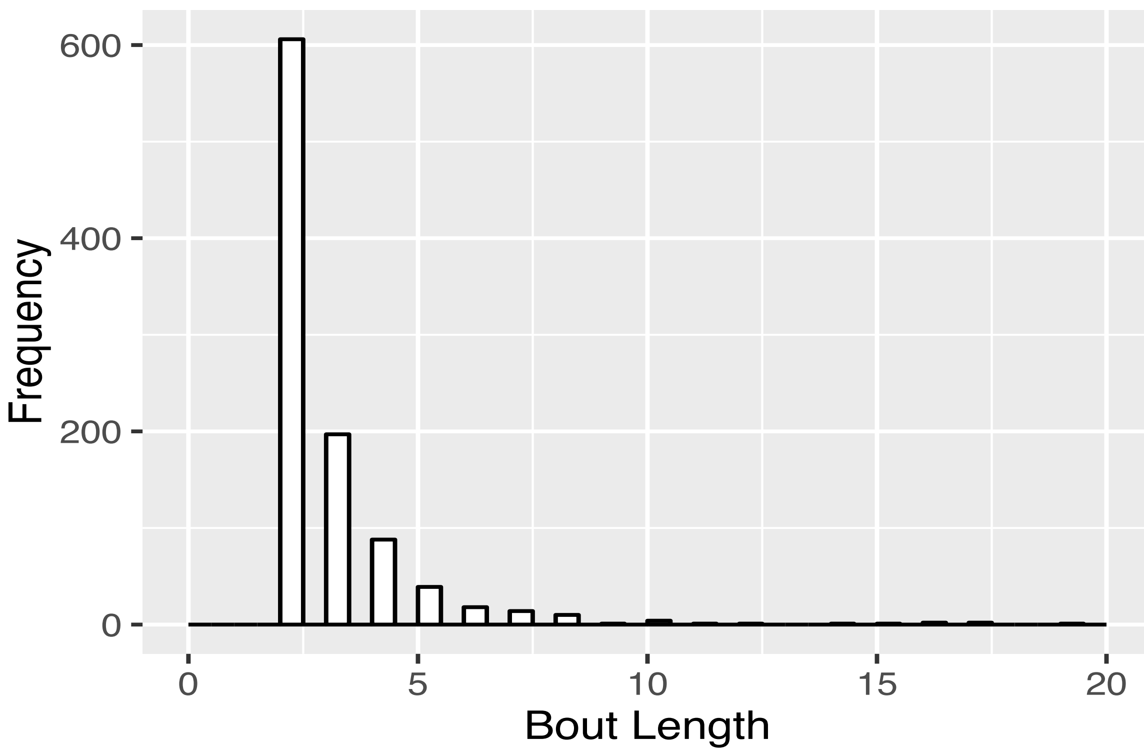

Figure 4.7. Repetition Bout Length

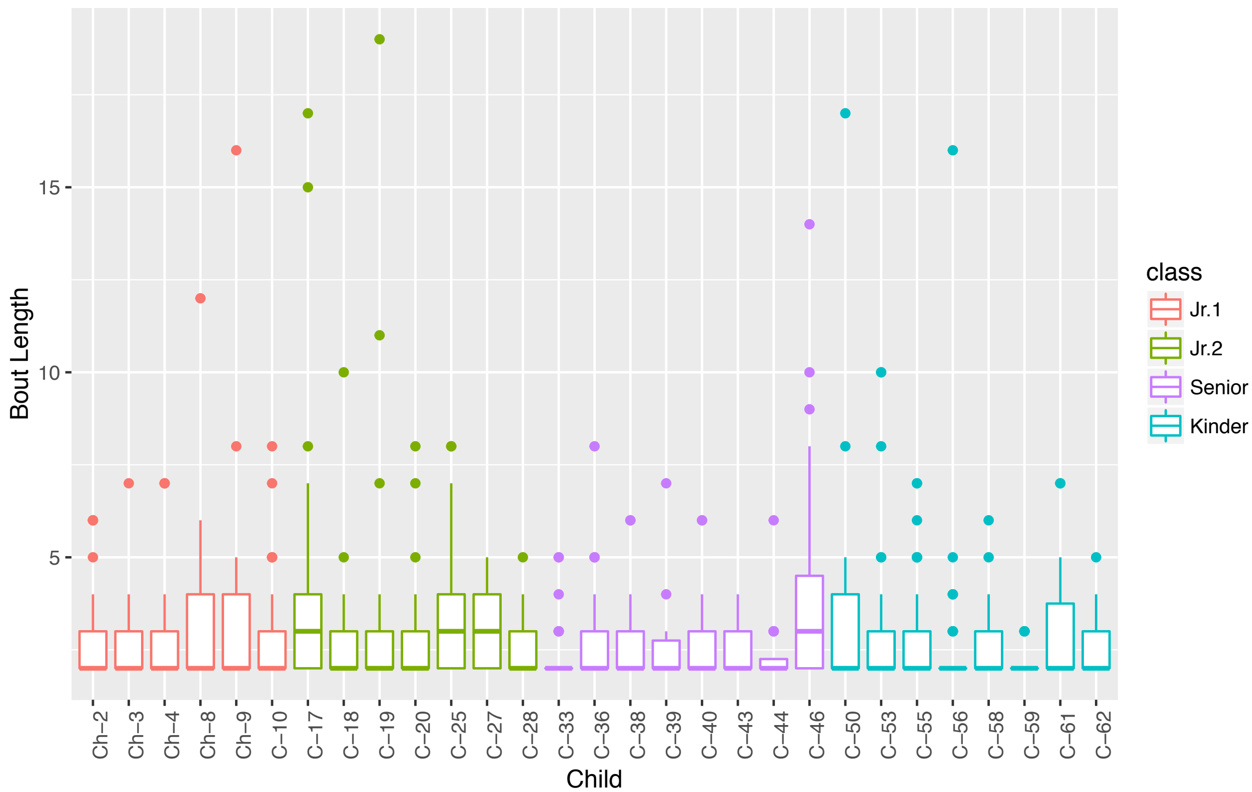

Figure 4.8. Repetition Bout Length by Child

I predicted that children would engage in long bouts of repetition. If this prediction were correct, Figure 4.7 would be a negatively skewed distribution. However, the data distribution shows a positive skew with most repetition bout two actions in length (Figure 4.1). Figure 4.8 displays repetition bout length by child. Distributions were similar across children, with the interquartile range falling under five. Points represent the instances where length was 1.5 times above the interquartile range.

A multilevel model with bout length as the dependent variable was run to determine whether age, focal follow length, repetition type or setting could explain bout length. An interaction between repetition type and setting was also included to determine whether repetition type reacted differently to setting. There was no main effect of repetition type, setting or age on bout length, nor was there an interaction effect (Table 4.3). The random effect of focal follow nested in Child ID explained more of the variance than fixed effects; however, the explanatory power of the full model was still low ($R^2_m = 0.008$; $R^2_c = 0.110$).

Table 4.3. Repetition Length Fixed and Random Effects

Fixed Effects	**Estimate**	**Std. Error**	**z-value**	**p-value**
(Intercept)	0.834	0.104	8.011	<0.001
Age	-0.031	0.024	-1.320	0.187
Focal Follow Length	0.004	0.003	1.045	0.296
Rep. Type (REF: motor)	0.131	0.077	1.712	0.087
Setting (REF: indoor)	0.228	0.132	1.723	0.085
Rep. Type * Setting	-0.226	0.142	-1.594	0.111
Random Effects	**Variance**	**Std. Dev.**		
Focal ID:Child ID	0.0350	0.1869		

Against prediction, repetitive bouts were short rather than long. Bout length was not affected by differences in age, focal follow length, setting or repetition type.

4.6 Discussion

Repetition was observed in a free play day care, confirming that repetition is not exclusive to Montessori environments. All twenty-eight children in the study engaged in some form of repetitive behaviour, with all but three children engaging in both motor and object manipulation repetition. Montessori did not specify types of repetition, although the classic anecdote is an example of object manipulation repetition; all children engaged in the type of repetition that Montessori used in her example. In addition to saying that repetition was “common to all” children, Montessori stated that repetition was “nearly constant in all their actions.” Repetition occurred in all events other than rough-and-tumble play. Its absence in rough-and-tumble play is not surprising considering that rough-and-tumble play is a social event. Instances of grappling, pushing and wrestling were coded as social actions, and therefore, were not included in this study. Therefore, motor and object manipulation repetitions occurred during all events in which motor and object manipulation actions were likely to occur.

The other two predictions were not supported. I predicted that children between 33 – 47 months would engage in more repetition than older children in the study (48 – 72 months). This prediction was based on Montessori's anecdote featuring a three-year-old girl, as well Evans et al. (1997) survey study, which identified 12 – 47 months as peak ages for repetition. In the current study, however, children of all ages engaged in similar amounts of repetition. It is possible that the results from this study did not match up with Evans' et al. (1997) study because the survey did not ask parents about repetitive action according to the same criteria as this study: uninterrupted sequences of repetition. Therefore, it may be the case that intermittent repetitions and preference for certain routines caused the age effect.

Similarity in repetition across all ages suggests the three-year-old girl in Montessori's anecdote is not representative of the age group most likely to engage in repetition. Repetition bout length results further suggest the anecdote is not the paradigm of repetition. Along with Montessori's description, I predicted that children would engage in long repetitive bouts. In direct contrast, repetition bouts were short, averaging at 2.86 repetitions in length. Although some observed bouts were much longer than the mean average, the longest repetitive bout was nineteen repetitions in length – far fewer than the forty-two repetitions described by Montessori.

The results against prediction do not refute Montessori's theory of repetition. Instead, the results suggest that Montessori's anecdotal description of repetition does not represent the norm. In the anecdote, Montessori notes that the girl's level of concentration was atypical. Consequently, concentration was not addressed in the current study. Although Montessori did not state that the long bout of repetition was atypical, it may be the case that long bouts of repetition only occur in combination with high levels of concentration. Therefore, long repetitions may not have been observed in the current study because high levels of concentration did not occur during focal follows. Montessori likely used this extreme example of repetition to demonstrate her point rather than present a typical case of repetition.

If repetition is an intrinsically motivated learning strategy, it seems more likely that repetitive bouts would be short rather than long. There is a long history of distributed versus massed practice research, dating back to psychologists in the 1940s and 50s (Lee & Genovese, 1988). According to this collection of research, short bouts of distributed practice are more beneficial to long-term learning than long, massed practice. These results have been consistent across various types of learning, from motor (Lee & Genovese, 1988) to academic learning (Gerbrier & Toppino, 2015; Schutte, Duhon, Solomon, Poncy, Moore, & Story, 2013). If self-initiated repetition is a learning strategy, short bouts over time would be a more effective strategy than massed practice.

In addition to practice length, varied practice is more beneficial to learning than repeating the same type of practice. This has been demonstrated in motor/object manipulation learning, such as learning to hit a target (Kerr & Booth, 1978), and in cognitive tasks, such as The Tower of Hanoi (Vakil & Heled, 2016). Varied repetitions were not recorded in the current study because the macro only recorded identical repeating patterns. Any changes in repetition were recorded as new bouts of repetition. Future work, however, should include study of variable repetition to determine how closely self-initiated repetition resembles practice patterns known to aid learning.

If repetition is an intrinsically motivated learning mechanism like babbling or repetitive kicking, it should be species-typical. Results in the current study suggest this is the case as all children in the study engaged in repetition. The next step then is identifying how repetition benefits learning. The current study suggests that repetition occurs in short bouts – a pattern known to benefit learning. If continued study demonstrates that repetition is also distributed and variable, there would be greater support for the hypothesis that self-initiated repetition aids learning.

Studying variability across age groups may reveal a progression in variability, in which repetition becomes increasingly variable from infancy to preschool-age. We see a similar progression in infant babbling, which progresses from repeating single phonemes to consonant-vowel strings to variegated babbling. Additionally, stereotyped motor behaviour described by Thelen (1979) only occurred until more variable forms of behaviour could be performed. Progression from stereotyped to variable behaviour is the result of advanced ability. It seems plausible, however, that not only does increased ability lead to more variable behaviour, but also allows for variable practice, which further increases the variability of behaviour. In such a scenario, ability and variability are part of a reinforcing cycle that advances learning.

Identifying repetitive patterns that contribute to learning would be beneficial to Montessori guides. Montessori guides are given little guidance on how to determine when a child is ready to move on to the next activity. They are instructed to advance children to the next set of work when a child has repeated an activity many times – an ambiguous guideline.

It is likely that guides also use other indicators to determine when a child is ready to move on, such as a child's mastery over a set of work. Determining whether a child has achieved mastery may be difficult, however, particularly for a new guide with little experience. He or she may become overly reliant on the rule of repetition: insistent that children repeat work even if learning is not occurring or assuming that repetition inevitably leads to learning. Therefore, it is important to recognize whether children are engaging in meaningful repetition. Short, distributed and varied repetition may be one indicator of learning. Variable repetition may be a particularly important indicator of learning as it contrasts with the highly stereotyped structure of infant and pathological repetition. Recognizing variability may be a practical way for Montessori guides to distinguish between pathological repetition and repetition that aids learning.

Future research should also compare repetition between free play and Montessori environments. Differences between the two environments are likely, not only because Montessori environments actively encourage repetition, but also because activity types differ between settings. Unlike free play environments, activities are highly specified in Montessori environments. Each set of work is performed in a certain way and specified order; there is a designated start and finish to each set of work. Therefore, repetition in a Montessori environment is likely repetition of an entire sequence. Montessori repetition is likely to be event-like while repetition in free play day cares is more likely to be repetitions of individual actions (as seen in the current study). Available activities will likely affect repetition type, which in turn will affect learning. For example, event-like repetition may help children learn to organize their activities and perform step-by-step sequences.

The results presented in this study are a small step in understanding repetitive behaviour as an intrinsically motivated learning strategy. These results suggest that there is a tendency for preschool-aged children to repeat activities, i.e., repetition is species-typical. The findings also direct future work on repetition to determine whether repetition is a natural tendency with learning value. Repetitive patterns were short, and if future work demonstrates repetitive bouts to also be distributed across time and variable, there is greater justification that repetition is beneficial to learning.

The gap between Montessori's anecdote of repetition and free play repetition suggests that Montessori guides should not be overly dependent on the anecdote during day-to-day practice. Montessori's anecdote is an atypical case rather than representative of all repetition. Identifying repetitive patterns that aid learning will be helpful for Montessori guides by providing indicators of meaningful repetitive practice. Understanding the structure of repetition will have theoretical and practical benefits for Montessori education.

4.7 Conclusion

Naturalistic observations of preschool-aged children were observed in a free play day care. The purpose of the study was to compare spontaneously occurring repetition to Montessori's anecdotal account of repetition. As predicted, all children engaged in repetition during their daily activities. Against prediction, however, repetitions were short and did not vary according to age. The results contrary to prediction do not refute Montessori's theory of repetition, but instead, indicate that Montessori's anecdote is not representative of repetition. This is the starting point for future work looking at intrinsically motivated repetition as a learning strategy in typically developing preschool-aged children.

CHAPTER V: GENERAL DISCUSSION

This thesis proposes that constructivism should be at the forefront of child development research. Constructivism is a theoretical approach, which proposes that children build their understanding of the world through a process of active engagement; knowledge is adjusted according to experience. Unlike rationalism-nativism and empiricism, constructivism is in agreement with the following principles: simple learning mechanisms guide development, concepts are built up in real time during day-to-day experiences and flexible knowledge construction allows us to adapt to our niche. Constructivism is proposed to be the optimal way to learn about variable environments.

It follows that a constructivist approach should use naturalistic observations to study learning. Knowledge acquisition takes place in the contexts of day-to-day life. Therefore, to understand the process of knowledge construction, it is necessary to observe behaviour in its natural context. Collecting naturalistic observational data is particularly beneficial when studying behavioural phenomena on which little is known: naturalistic observations are essential in hypothesis generation and ensuring experimental work has external validity. This project used naturalistic observations to study repetition in preschool-aged children, which is currently not understood other than in pathological cases.

Ecological psychology was introduced in Chapter III as a theoretical framework to understand the interaction of behaviour and environment. The challenge of studying behaviour in natural contexts is dealing with the complex environment. Therefore, Barker's behaviour settings theory, which provides a system for parsing the environment into manageable units that are useful for explaining behaviour, was applied to the current study.

The primary reason for applying behaviour settings theory was to find out whether setting needed to be accounted for in the study of repetition. It also provided an opportunity, however, to test the usefulness of a behaviour settings survey with respect to identifying distinct behaviour settings and using these to make accurate predictions based on setting. Although not all results were in line with prediction, behaviour settings theory proved its usefulness for explaining behaviour, as my analysis was aimed at determining whether motor and object manipulation rates differed according to setting, and, hence, whether it was necessary to account for rate differences in repetition depending on where the child in question was located. Specifically, object manipulation rates were found not differ across settings, but motor rates differed between indoors and outdoors.

Studying repetition provided the starting point for understanding preschool-aged repetitive behaviour as a self-initiated behaviour that aids learning. Repetition was studied, however, to specifically address claims made in Montessori theory. Montessori education is promoted as a method founded on science. If such scientific claims cannot be substantiated, however, there is the risk that this discredits Montessori's work rather than validates it. Considering the emphasis placed on the scientific origins of the Montessori method, it is necessary to empirically test these claims. Parents, policy-makers and child advocacy groups may support Montessori methods based on the assumption it is scientifically supported. Therefore, there is a risk of implementing methods that are ineffective or disadvantageous.

Testing Montessori's claims will determine whether the natural tendencies she observed are typical across all children or if her observations were purely anecdotal. In the process, valuable information about children's learning and development may be discovered, particularly for implementation in the Montessori environment. The results of this study suggest that Montessori guides should not be overly reliant on Montessori's anecdotes of behaviour. Montessori's account of repetition was not representative of repetitive behaviour in the current study: repetitive bouts were short rather than extended, and children of all ages engaged in equal amounts of repetition. Continued research on repetition is needed to investigate the type of repetitive behaviours that can be expected in preschool-aged children and the structure of repetitions that would benefit learning.

Training programs directed by Association Montessori Internationale (AMI) do not supplement Montessori's work, however. The association was created by Montessori to maintain the integrity of her method. In addition to offering training programs, AMI provides school accreditation and advocates for the Montessori method. To preserve Montessori's original methods, AMI demands adherence to strict criteria. To be AMI accredited, schools must follow certain guidelines, such as only hiring AMI-trained guides, only buying materials from approved suppliers, keeping Montessori's recommended child-guide ratios, and receiving AMI consultations every few years. In the AMI training program, only books written by Montessori or approved by her before her death are used. AMI training programs thus provide a rather narrow and often limited understanding of child development.

Further studies of children's natural behaviour are needed to address whether the "natural tendencies" of children described by Montessori really are spontaneously occurring behaviours that occur in the context of children's day-to-day lives. Studies currently conducted on Montessori education are largely assessments of academic outcomes, rather than studies of the underlying theory and its assumptions (Ahmadpour & Mujembari, 2015; Kayili & Ari, 2011; Lillard, 2012; Ongoren & Turcan, 2009). Studying the theory behind the method is imperative, not only because it may identify the root causes of academic success, but also because Montessori education was not intended to be academically focused. Rather, Montessori education is meant to satisfy children's developmental needs. A greater emphasis on studying the theoretical and developmental aspects of Montessori education would pay dividends by confirming whether the principles assumed to explain its success in terms of learning outcomes actually apply.

Further work should address Montessori's theory on development, beginning with natural histories of behaviour that Montessori deemed part of normal development (i.e., children have a love of silence, prefer order in the environment, display extended concentration and exhibit discipline). The current study has made headway in the study of repetition as a natural tendency. The commonality of repetition across all children suggests that repetition is a behaviour worth further study: it is a species-typical behaviour that may have developmental benefits. From here, naturalistic observations of repetition can be recorded to find out whether repetition structure reflects patterns known to aid long-term learning (i.e., whether it is distributed and varied). Additionally, event-like repetition and repetition of individual actions should be compared. Activities in Montessori environments differ from free play care activities in that Montessori activities involve sequences of behaviour with strict beginnings and ends. Understanding the repetitive structure in these two environments is important in the study of repetition because Montessori claimed that repetition is common in all children's behaviour. Repetition is likely to vary, however, based on the activities that are available in the environment.

Studying Montessori education works well within a constructivist framework. Montessori education is grounded in action on the environment – children move through the environment and engage with materials actively, and through this they guide their own learning and construct their own knowledge. Studying action necessitates an interest in motor and object manipulation development. The current study presented motor and object manipulation as behaviour central to epistemological work.

Also as a result of a constructivist framework, this project advocates the use of naturalistic observations. Naturalistic observations were conducted not only to study repetition, a behaviour on which little is known, but also to demonstrate the usefulness of studying behaviour in natural contexts. Through naturalistic observations, baseline information about repetition, which is not available through laboratory experiments or questionnaires, was recorded. Ecological work, such as Gibson's ecological psychology and Barker's behaviour settings theory, was introduced as a framework for studying behaviour in natural contexts. Tools for ecological study are available; now naturalistic study as a means to understand action-environment relationships, and consequently knowledge acquisition, can follow.

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APPENDICES

Appendix 1

BODY MOVEMENT UNITS

Automanipulation – manipulating one's self, such as rubbing eyes or brushing hair, facial movements (sticking out tongue, pouting), touching one's face, putting an object in mouth (includes drinking) or hiding one's face.

Balance – lifting one or two legs to balance, includes balancing on one leg, buttocks or hanging by hands.

Bend – forward or backward hip flexion.

Crouch – knees bent, but weight still on feet.

Fall – going from an upright position to the ground. Falls may be accidental or intentional.

Fine motor motion – single movement of hands or fingers.

Fine motor movement – repetitive or sustained movement of hands or fingers that does not involve manipulating an object.

Gross motor motion – single movement of torso or limbs.

Gross motor movement – repetitive or sustained movement of body or limbs without object. Examples include waving arms up and down through the air, shaking head back and forth (without communicative intent), kicking legs.

Hands and knees – getting onto hands and knees and remaining stationary.

Hit – extending arm or arms, and using one's hand or an object being held to forcefully make contact with another individual or object.

Jump/hop – moving suddenly upward by leg and foot extension, landing on two feet (jump) or one foot (hop)

Kick – extending one leg suddenly, causing foot to make forceful contact with an object.

Kneel – weight supported on one or both knees and lower legs.

Lie – position body horizontally against a surface.

Point – extending arm, either with an extended finger or while holding an object, toward an object or individual.

Reach – extending arm and fingers in an attempt to grasp an object, or extending arm while holding an object to make contact with an object not in possession.

Reposition – making slight changes in bodily position, such as repositioning on a couch to make room for another child, but does not involve moving to a new location.

Sit – weight supported by buttocks, which is in contact with a surface.

Shuffle – moving feet along the substrate without losing contact with it.

Spin – turning one's body rapidly in circles.

Stand – standing with both feet, weight mainly or wholly on feet.

Trip – stumble but does not fall.

LOCOMOTOR UNITS

Backward movement – backward movement by any modality (walking backwards, crawling backwards, scooting backwards, etc.).

Crawl – moving forward on hands and knees.

Climb – gross physical activity with three of four limbs resulting in a vertical motion of the whole body (up or down).

Circle –walking in a complete circle around an object.

Forward movement – forward movement on knees or buttocks, usually over short distances.

Group run – running in a coordinated fashion with other children.
Run – moving the body forward at a rapid pace, alternating legs and with both feet off the ground instantaneously during each stride.
Roll – moving one's body across a surface by turning the body.
Side movement – movement to the side, whether on feet, knees, buttocks.
Skip – moving the body forward by alternating legs, placing one foot on the substrate and hoping slightly on it before shifting the weight to the other foot to repeat the same movement.
Slide – moving the body in constant frictional contact down an inclined surface.
Walk – moving the body forward at a moderate pace, alternating legs and placing one foot firmly on the substrate before lifting the other.
Wander – walking through the room without a direct path. Wander is indicated by multiple changes in direction.
VISUAL UNITS
Examine – looking at an object or a part of one's self (such as a scab on one's arm) along with tactile examination.
Glance – visual gaze of one second or less directed to another individual.
Joint attention – attention between two or more individuals is brought to the same point, such as looking at a book together.
Look –visual fixation at an object or an individual's face for more than a second (thus differentiated look from glance).
Look around – looking around room or play centre without prolonged visual fixation.
Look distance – prolonged visual fixation into the distance beyond the child's immediate surroundings, such as looking out the window, or if looking indoors, looking at something outside of the centre he or she is in.
Stare – unfocused gaze.
Watch – prolonged visual fixation on another individual or group of individuals, while the individual or group are performing an action, such as colouring, walking, or talking.
SOCIAL UNITS
Dispute object – attempts to retain an object in conflict for possession.
Dominate – taking or keeping possession of an object when another child was in possession or attempting to get possession of it.
Fail take object – grasps object in attempt to take from another child, but then lets go.
Hold hands – grasping another individual's hand.
Hug/hugged – encircling arms around another individual, object or self (hug). Receive a hug (hugged).
Join – stand in close proximity to an individual or group of child(ren)/adult(s) after traveling towards them.
Listen – focal child listens to another individual with minimal to no response. Since the focal child is non-responsive, he/she child must be looking at the individual speaking to him/her to be sure listening is occurring. Also, listening when someone is whispering into child's ear.
Nod – nodding head up and down to communicate with another individual – indicating "yes" or agreement.
Receive – grasping an object given by another individual.

Shake no – shaking head from side to side to communicate "no" or disagreement with another individual.
Show – bringing another individual's attention to an object or part of self, typically being held.
Submit – loses possession of an object from another child.
Tease – provoking in a playful way, may involve verbal teasing or facial gestures, such as sticking out one's tongue.

PLAY UNITS

FIGURINE/ANIMATION PLAY STATES

Animation movement – grasping and moving an object while pretending it is an animated being. This may include moving the object with wrist rotation when pretending the object is talking or moving the object across a surface when pretending the object is walking. Moving an object through the air as if it is flying is coded as "fly object".
Crash – hitting two objects together.
Fly object – moving an object through the air without contact to a surface. Fly object include an arm extension, holding an object up while walking, arm movements causing the object to move up and down, or twisting an object in the air. This behaviour state is common in figurine, animation and vehicle play.

VEHICLE PLAY STATES

Slide object – grasping an object and moving it across a surface, maintaining contact with the surface.

FANTASY PLAY STATES

Object fantasy play – fantasy play with dramatic play toys, such as plastic food, tea set, menus, medical kit, etc. Object fantasy play is part of fantasy play rather than object use because there is an "as if" component to the toy use. For example, while the child may be performing the action of pouring when tilting a teapot spout over a teacup, the child is not literally pouring. The child is pretending to pour, and the pretending component is what differentiates this behaviour from a general object use unit.

ROUGH AND TUMBLE PLAY STATES

Fighting stance – holding a pose during rough and tumble or fantasy play. Typically, feet are wider than hip width apart and arms are in the air, bent at elbow and hands in fists.
Full body contact – putting one's body weight against another individual, object or surface. Includes leaning.
Pull – apply force to an object or another individual by arm and trunk flexion, causing it to move away from its original position.
Push – applies force to an object or individual (in the case of rough and tumble play) by limb and trunk extension, causing it or him/her to move away from original position.
Wrestle – mocking fighting with another individual that includes grappling or sustained contact (body contact, limb contact, as in arm wrestling, or repeated hand contact).

ART STATES

Colour – back and forth motion of a colouring utensil (crayon, pencil crayon, marker) to create solid sections of colour (colouring a colouring sheet or free-hand colouring).
Cut – using scissors to sever material, such as paper, into multiple pieces.
Draw – Using any writing utensil (pen, pencil crayon, marker, etc.) to create fine-lined markings on a surface
Erase – using an eraser to remove a drawn image.

Fold – crease bendable material, such as folding paper.
Glue – applying glue to any art material.
Paint – using an object, such as a brush or sponge, or finger to apply paint to any material.
Stencil – tracing a stencil with any writing utensil.
Stick – attaching materials together using adhesive, such as glue.

BUILDING STATES

Build – constructing a structure out of multiple pieces, which may include combinations of different materials. Materials include but are not limited to wooden blocks, foam blocks, Legos, toilet rolls, and connectors.
Deconstruct – taking apart all or part of a structure or object. Unlike "knock down", deconstruct is careful and purposeful. Often it is part of the building process where part of the structure is taken apart for reconstruction.
Knock down – using a body part or held object to forcefully knock over a structure.

PLAY DOUGH STATES

Add – adding more play dough to the amount he/she is already working with.
Press – applying sustained pressure for more than one second with one's palm, finger or tool being held
Pat – repeatedly lifting and making contact with an object, substance or surface. Examples would be patting play dough to flatten or patting a puzzle piece into place.
Roll object – circular or back and forth movements of the palm to manipulate the play dough into a sphere or cylinder.

PUZZLE STATES

Fit – joining complementary pieces together.
Rotate – turning an object, such as a puzzle piece to more easily determine what way it fits into the puzzle.

WATER TABLE/SAND TABLE STATES

Dip – dunking an object under water and immediately lifting it out of the water
Submerge – pushing an object under water and holding it under for an extended period of time rather than lifting it out immediately. Holding the object under water differentiates submerge from the behaviour unit "dip".
Scoop – using tool or hand to collect water or sand and lift.
Pour – tipping an object (typically some sort of container) holding liquid (or sand), causing the liquid to empty out.
Stir – moving an object in a circular motion through another substance, such as water or sand.
Insert – placing an object into another object, such as a malleable object (stick into sand or play dough) or a tight opening (stick into vent)
Dig – using a tool or body part to create a hole.
Cover – covering an object with sand or other object to conceal the object from view.
Uncover – removing an object or substance, such as sand, shielding an object from view.

GENERAL OBJECT USE UNITS

Adjust – repositioning an object, such as repositioning blocks in a tower to better balance another block on top or turning a piece of clothing right-side-out before putting it on.
Close – making the interior of an object or another space inaccessible (for example, closing a box or closing a door).

Dump –tipping a container, causing the contents to fall out. This differs from the behaviour unit "pour," which indicates liquid (or sand) being emptied out of a container.
Fine manipulation – movement of an object involving fine muscular activity of fingers or hands.
Fix – repairing a broken part of an object, such as putting a broken toy back together. This does not include objects that are meant for putting together and taking a part (e.g. puzzle, building blocks).
Gather – collecting objects into a group or pile, differs from the behaviour unit "sorting" because gather does not involve creating separate groups of objects according to a particular feature.
Give – holding out an object to another individual and releasing grip when the object is taken by the other person.
Grasp – encircling fingers around object and tightening grip
Gross manipulation – sustained or repetitive movement of an object by gross limb activity, such as shaking, hitting, kicking, pushing, pulling an object.
Hand fumble – moving hands and fingers together randomly. Children may hold an object during hand fumble.
Hold – holding an object in a stationary position (e.g. holding microphone when singing into it).
Hold out – attempting to give an object to another individual by holding it out to them, but it is not taken.
Lift – raising an object with a limb extension.
Line – placing objects in a row.
Make contact – touch body part or object to another object.
Open – making an object's interior, which was previously inaccessible, accessible; or making a larger space accessible by, for example, opening a door.
Pick up – obtaining an object by grasping followed by a continuous arm movement.
Pull back – pulling back arm while holding in object to move an object out of reach of another individual.
Put down – releasing an object by loosening grasp (includes dropping).
Put in – placing an object inside another object or cubby.
Rub – back and forth or circular movements on an object with palm, side of fist or thumbs.
Sort – creating groups of objects according to a particular feature, such as sorting objects into groups according to colour.
Squeeze – tightening grip around object or person.
Sweep – using a brush or broom to collect objects in a pile or into a dustpan.
Take out – removing an object from inside of another object, such as taking play dough out of a mould.
Tap – repeatedly and briefly making contact with an object, either with hand, finger or object being held.
Throw – moving an object through the air by releasing from hand at the end of arm extension.
Wipe– remove a substance by brushing or dusting, such as dusting sand off hands or "wiping" off a kiss given by another child.

OTHER BEHAVIOUR UNITS

Acted on – passively allows another individual to act on him/her, such as allowing another individual to put a hat on them.
Begin action – beginning an action but not following through. For example, starting to pick up an object but then releasing.
Dress off– taking off an article of clothing or object being worn.
Dress up – putting on an article of clothing or object that can be worn (even if it is not intended for wearing).
Hide – putting one's body in a place that is out of the view of others, such as under a piece of furniture, blanket or in cubby space (includes hiding one's face).
Leave room – leaves observation area (classroom or outdoor area).
Read – looking at a book (not necessarily "reading," most likely looking at the pictures).
FAILED ACTIONS
Failed manipulation – failure to manipulate object, such as fitting a puzzle piece.
Failed social action – failure to engage with or act on another individual (e.g., failing to put a shoe on another child's foot).
Failed automanipulation_ - failed action on self, such as failure to braid own hair.
Failed motor action – failure to perform a motor action, such as inability to climb structure.

Appendix 2
Event Coding
General Rules:

- each event is initiated by event-specific rules (see below).
- an event ends after four non-event related actions have occurred in a row.
- an event ends if another events begins.

Animation – animating an inanimate object by giving it motion or pretending it is alive. This often involves animating toys, such as action figures, stuffed animals, human figurines, and animal figurines, which are made to represent living things. Animation play also includes animating objects that are not representative of living creatures, such as pompoms or bits of paper. Animation play typically involves pretending objects can talk, walk and interact with one another. Includes car/train play in which a toy car/train is pushed over solid surfaces (along the ground or a track) and must involve car or train sound effects vocalized by the child.
Animation Rules:

- Must be initiated by a vocalization, such as sound effects or words that make it clear the child is engaging in animation play. Sounds effects may include "vrmm, vrmm," "beep beep," or "choo choo." Speech during animation play often involves speaking on behalf of the animated object, and children typically alter their speaking voice (for example, speaking in a higher pitch).
- Animation play can also be initiated by planning animation play (for example, saying "he's going to fart" about a stuffed dog).
- Once animation play has been initiated by a vocalization, play is continued by actions that follow along with the theme of animation. If a child is pretending a bottle is a rocket, continuation of animation play may be moving the bottle up and down through the air. If playing with a figurine, continuation of animation play may include walking the figurine across the substrate or using the figurine to knock over blocks.

Construction – activity that involves creating something out of multiple parts. This includes art activities or building from materials such as blocks or puzzle pieces. May involve the deconstruction of structures as well.

Construction Rules:

- Initiated by bringing two constructive objects together, such as bringing marker to paper and colouring, applying glue to paper, stacking blocks on top of each other, etc.
- Once construction has been initiated, it can then include deconstructive actions, such as knocking down a tower, erasing or taking a part a puzzle. These actions do not initiate construction.
- There are a few special instances of construction. One examples is constructing with play dough. Often, particularly with young children, playing with play dough seems to be manipulation only. However, instances in which children label something they have made with play dough, such as "here is a cupcake," a construction event has begun. We can then suppose that further interaction with the play dough is constructive in nature.

Fantasy play – play involving "as if" situations, in which individuals, objects or settings are other than reality: individuals take on an identity, such as a mother or another animal, in role playing; objects become something else, such as a banana being used as a telephone; or the child is pretends to be in a different setting (such as setting up chairs in the classroom and pretending to be on a plane).

Fantasy Play Rules:

- Like animation play, fantasy play is initiated by a vocalization, including planning the play event.
- After fantasy play has been initiated, fantasy play is continued by actions specific to that play event, which vary greatly between types of fantasy play. For example, fantasy play in the dramatic play centre may be initiated by giving another individual a cup and telling them it's coffee. Then, the fantasy play event is continued by moving similar toys (cups, plates, pots, etc.) around the centre as a child pretends to prepare a meal. If a child has set up a row of chairs and is pretending he/she is sitting on a plane, continuation of the fantasy play event may be buckling up, pretending to fly the plane, or loading up the plane with "cargo".
- If a fantasy play event has already taken place during a focal follow, a re-initiation of the event during the same focal follow doesn't require a verbalization. Rather, only the same pattern of actions is required. For example, a child may have barked to initiate the play event of pretending to be a dog. Then, he continued the play event by fetching a ball and bringing it back to another child. After a break of non-fantasy play (more than four non-fantasy play actions in a row) fetching and bringing a ball back to another child can be labeled as fantasy play even if the child did not bark again to initiate the fantasy play event.

Rough-and-tumble play – social play involving physical contact, such as grappling, wrestling or other bodily contact. The intent is non-aggressive.

Rules for rough-and-tumble play:

- Rough-and-tumble play can be initiated by sustained physical contact, such as wrestling (or arm wrestling).
- Rough-and-tumble play can also be initiated by repeated contacts, such as hits or pushes. However, isolated hits or pushes do not constitute rough and tumble play.

Therefore, for rough-and-tumble play to occur there must be multiple contacts where the third contact is the start of rough-and-tumble play.
- In rough-and-tumble play, one child may take a dominating role. If a child is being pushed and chased by another child, this counts as rough-and-tumble play; however, the child being pushed and chased must be a consenting play partner.
- Non-contact actions, such as fighting stance and chase, can continue the rough-and-tumble play event.

Travel – moving between centres.

Appendix 3
Focal Follows and Observation Times

Class	Child ID	Setting	Focal Follows	Length (minutes)
Jr.1	Child-2	Indoors	1	12
		Outdoors	2	9
		Indoors	3	20
		Indoors	4	17
		Indoors	5	1
		Indoors	6	20
		Outdoors	7	22
		Indoors	8	21
		Indoors	9	20
		Indoors	10	20
		Indoors	11	36
		Outdoors	12	3
				Total=201 **Avg.**=17
Jr.1	Child-3	Indoors	1	20
		Indoors	2	20
		Indoors	3	3
		Outdoor	4	17
		Indoors	5	20
		Indoors	6	20
		Indoors	7	9
		Outdoors	8	11
		Indoors	9	40
		Indoors	10	20
		Indoors	11	20
				Total=200 **Avg.**=18
Jr.1	Child-4	Indoors	1	24
		Indoors	2	13
		Outdoors	3	7
		Indoors	4	20
		Indoors	5	16
		Indoors	6	10
		Outdoors	7	10

		Outdoors	8	20
		Outdoors	9	17
		Outdoors	10	20
		Indoors	11	6
		Indoors	12	20
		Indoors	13	20
				Total=203 **Avg.**=15.5
Jr.1	Child-6	Indoors	1	40
		Outdoors	2	20
		Indoors	3	19
		Outdoors	4	1
		Indoors	5	24
		Outdoors	6	20
		Indoors	7	20
				Total=144 **Avg.**=20.5
Jr.1	Child-8	Indoors	1	20
		Indoors	2	20
		Outdoors	3	18
		Indoors	4	20
		Outdoors	5	20
		Indoors	6	19
		Indoors	7	20
		Indoors	8	16
		Outdoors	9	4
		Indoors	10	20
		Indoors	11	3
		Outdoors	12	20
				Total=200 **Avg.**=16.5
Jr.1	Child-9	Indoors	1	40
		Indoors	2	20
		Indoors	3	19
		Indoors	4	20
		Indoors	5	21
		Indoors	6	20
		Indoors	7	20
		Indoors	8	20
		Outdoors	9	20
				Total=200 **Avg.**=22
Jr.1	Child-10	Indoors	1	20
		Indoors	2	19
		Indoors	3	20
		Indoors	4	19
		Indoors	5	26
		Indoors	6	16
		Indoors	7	20

		Outdoors	8	20
		Indoors	9	20
		Indoors	10	20
				Total=200 **Avg.**=20
Jr.2	Child-6	Indoors	1	20
		Indoors	2	20
		Indoors	3	16
				Total=56 **Avg.**=18.5
Jr.2	Child-17	Indoors	1	20
		Indoors	2	10
		Outdoors	3	10
		Indoors	4	20
		Indoors	5	20
		Indoors	6	18
		Outdoors	7	2
		Indoors	8	20
		Indoors	9	20
		Indoors	10	12
		Outdoors	11	12
		Indoors	12	13
		Outdoors	13	7
		Outdoors	14	7
		Indoors	15	9
				Total= 200**Avg.**=13.5
Jr.2	Child-18	Indoors	1	20
		Outdoors	2	15
		Outdoors	3	20
		Indoors	4	20
		Indoors	5	16
		Outdoors	6	4
		Indoors	7	20
		Indoors	8	20
		Indoors	9	20
		Indoors	10	17
		Indoors	11	20
		Indoors	12	8
				Total=200 **Avg.**=16.5
Jr.2	Child-19	Indoors	1	22
		Indoors	2	20
		Indoors	3	20
		Outdoors	4	20
		Indoors	5	20
		Indoors	6	20
		Indoors	7	20
		Indoors	8	20

		Indoors	9	20
		Indoors	10	21
				Total=203 **Avg.**=20
Jr.2	Child-20	Indoors	1	20
		Indoors	2	20
		Indoors	3	20
		Indoors	4	20
		Indoors	5	20
		Indoors	6	20
		Indoors	7	12
		Indoors	8	20
		Outdoors	9	20
		Indoors	10	20
		Indoors	11	8
				Total=200 **Avg.**18
Jr.2	Child-25	Outdoors	1	20
		Indoors	2	20
		Outdoors	3	20
		Outdoors	4	20
		Indoors	5	5
		Outdoors	6	15
		Indoors	7	12
		Outdoors	8	8
		Indoors	9	20
		Indoors	10	20
		Indoors	11	16
				Total=176 **Avg.**=16
Jr.2	Child-27	Indoors	1	10
		Outdoors	2	10
		Indoors	3	20
		Indoors	4	8
		Outdoors	5	12
		Indoors	6	8
		Outdoors	7	12
		Indoors	8	20
		Indoors	9	21
		Outdoors	10	20
		Indoors	11	20
		Indoors	12	15
		Outdoors	13	20
		Indoors	14	4
				Total=200 **Avg.**=14.5
Jr.2	Child-28	Outdoors	1	20
		Indoors	2	20
		Indoors	3	20

		Indoors	4	20
		Indoors	5	20
		Outdoors	6	20
		Outdoors	7	20
		Indoors	8	13
		Outdoors	9	7
		Indoors	10	20
		Indoors	11	20
				Total=200 **Avg.**=18
Jr.2	Child-30	Outdoors	1	20
		Indoors	2	20
		Indoors	3	20
		Indoors	4	20
		Indoors	5	2
		Outdoors	6	18
		Indoors	7	20
				Total=120 **Avg.**=17
Senior	Child-30	Indoors	1	20
		Indoors	2	20
		Indoors	3	20
		Indoors	4	20
				Total=80 **Avg.**=20
Senior	Child-33	Indoors	1	20
		Indoors	2	6
		Indoors	3	20
		Indoors	4	6
		Indoors	5	20
		Indoors	6	14
		Outdoors	7	6
		Indoors	8	20
		Indoors	9	20
		Indoors	10	20
		Outdoors	11	20
		Indoors	12	20
		Outdoors	13	8
				Total=200 **Avg.**15.5
Senior	Child-36	Indoors	1	20
		Indoors	2	20
		Indoors	3	21
		Outdoors	4	20
		Outdoors	5	20
		Indoors	6	20
		Indoors	7	20
		Indoors	8	40
		Outdoors	9	8

		Indoors	10	2
		Outdoors	11	9
				Total=200 **Avg.**=18
Senior	Child-38	Indoors	1	20
		Indoors	2	15
		Indoors	3	20
		Indoors	4	20
		Indoors	5	20
		Indoors	6	20
		Indoors	7	20
		Indoors	8	20
		Indoors	9	20
		Outdoors	10	6
		Indoors	11	19
				Total=200 **Avg.**=18
Senior	Child-39	Indoors	1	20
		Indoors	2	20
		Indoors	3	20
		Indoors	4	20
		Indoors	5	40
		Indoors	6	20
		Indoors	7	17
				Total=157 **Avg.**=22.5
Senior	Child-40	Outdoors	1	20
		Indoors	2	21
		Indoors	3	20
		Outdoors	4	20
		Indoors	5	20
		Indoors	6	11
		Outdoors	7	9
		Indoors	8	9
		Outdoors	9	10
		Indoors	10	20
		Outdoors	11	20
		Indoors	12	10
		Outdoors	13	10
				Total=200 **Avg.**=15.5
Senior	Child-43	Indoors	1	24
		Outdoors	2	16
		Indoors	3	20
		Outdoors	5	20
		Indoors	6	20
		Indoors	7	20
		Indoors	8	20
		Indoors	9	36

		Outdoors	10	6
		Indoors	11	16
		Outdoors	12	2
				Total=200 **Avg.**=16.5
Senior	Child-44	Indoors	1	20
		Indoors	2	20
		Indoors	3	20
		Indoors	4	40
		Indoors	5	20
		Outdoors	6	20
		Indoors	7	15
		Outdoors	8	5
		Indoors	9	20
		Indoors	10	20
				Total=200 **Avg.**=20
Senior	Child-46	Indoors	1	20
		Indoors	2	45
		Outdoors	3	20
		Indoors	4	20
		Indoors	5	20
		Indoors	6	20
		Outdoors	7	20
		Indoors	8	4
		Outdoors	9	15
		Indoors	10	20
		Outdoors	11	6
				Total=210 **Avg.**=19
Kinder	Child-50	Indoors	1	20
		Indoors	2	20
		Indoors	3	20
		Indoors	4	20
		Indoors	5	20
		Indoors	6	20
		Indoors	7	10
		Outdoors	8	10
		Indoors	9	40
		Outdoors	10	20
				Total=200 **Avg.**=20
Kinder	Child-53	Indoors	1	20
		Outdoors	2	20
		Indoors	3	20
		Outdoors	4	20
		Indoors	5	20
		Indoors	6	20
		Indoors	7	20

		Indoors	8	20
		Indoors	9	20
		Outdoors	10	20
				Total=200 **Avg.**=20
Kinder	Child-55	Indoors	1	10
		Outdoors	2	10
		Outdoors	3	20
		Indoors	4	20
		Indoors	5	17
		Indoors	6	20
		Indoors	7	18
		Indoors	8	20
		Indoors	9	20
		Indoors	10	20
		Indoors	11	20
		Outdoors	12	4
				Total=199 **Avg.**=16.5
Kinder	Child-56	Indoors	1	20
		Indoors	2	20
		Indoors	3	16
		Outdoors	4	4
		Indoors	5	20
		Indoors	6	20
		Indoors	7	20
		Indoors	8	37
		Indoors	9	20
		Outdoors	10	20
				Total=197 **Avg.**=20
Kinder	Child-58	Outdoors	1	20
		Outdoors	2	20
		Indoors	3	20
		Indoor	4	40
		Indoors	5	20
		Indoors	6	20
		Indoors	7	20
				Total=160 **Avg.**=23
Kinder	Child-59	Outdoors	1	10
		Indoors	2	40
		Indoors	3	18
		Indoors	4	20
		Indoors	5	20
		Indoors	6	60
		Indoors	7	20
		Indoors	8	12
				Total=200 **Avg.**=25

Kinder	Child-61	Outdoors	1	20
		Indoors	2	18
		Outdoors	3	2
		Indoors	4	20
		Outdoors	5	20
		Indoors	6	20
		Indoors	7	20
		Indoors	8	5
		Indoors	9	40
		Indoors	10	20
				Total=185 **Avg.**=18.5
Kinder	Child-62	Outdoors	1	20
		Indoors	2	20
		Indoors	3	20
		Outdoors	4	20
		Indoors	5	20
		Indoors	6	20
		Indoors	7	20
		Indoors	8	18
		Indoors	9	7
		Indoors	10	20
		Indoors	11	11
				Total=196 **Avg.**=18

Appendix 4
Indoor Toy Inventory by Play Area

Play Area	Jr.1	Jr.2	Senior	Kinder
Dramatic Play Centre	Dress-up clothes Plastic food Babies Muffin tins Pots Rubber gloves Teacups, saucers Plates	Dress-up clothes Phone Puppets	Wallets, purses Phone Food boxes Foam fruit, veggies Play money Cash register Dust pan/brush Baskets	Pots Flashlights Camping stove Camera
Puzzle Centre	Jigsaws Magnetic mazes Play dough tools (knives, lifters,	Jigsaws Connectors Potatohead Wooden fish	Jigsaws Connecting links Tossing game Matching puzzle.	Combined with Book Centre

	scissors, rolling pin) Magnetic dolls	Shakers Button board Zipper board	Memory game Self-help board	
Building Centre	Foam blocks Trucks Cars	Wooden blocks Trucks Train table Train cars Stuffed people Lrg. Connectors	Wooden blocks Tool box Goggles Hammer Saw Hats Vests	Wooden blocks Ppl. figurines Train tracks Train cars
Art Centre	Foam stickers Crayons Scissors Paper Tissue paper Glue Feathers Pompoms	Pencil crayons Crayons Design scissors Paper Noodles Tin foils Pipe cleaners Pompoms Letter cutouts	Popsicle sticks Crayons Scissors Paper Tissue paper Glue Feather Pompoms Pipe cleaners	Pencil crayons Popsicle sticks Scissors Paper Tissue paper Glue sticks Pipe cleaners Pompoms Foam shapes Markers Lace Cotton balls
Sand Table	Sand Beads Shovels Pails Sieves Rakes Water wheel	Sand Basket Giraffe Elephants Wooden blocks Lego blocks	Shredded paper Bucket Shovel Bin Sieve Rake	Dirt Dinosaurs
Book Centre	Books Pillows	Books	Books	Books Jigsaws Log blocks
Eating Area	Lunch tables Chairs	Lunch tables Chairs	Lunch tables Chairs	Lunch tables Chairs
Water Table	Nets Sieves Water wheels Buckets Tubes Turkey baster	Nets Boats Sea animals Shells	Babies Bottles Clothes	None

Misc. Centre	None	Twigs Pinecones Magnify glass Seeds Rabbit feces (in jar)	None	Looms Elastics
Writing Centre	None	None	Pencils Paper Word templates	Pencils Pens Paper Envelopes Eraser

Appendix 5
Toy Changes By Date

Date	**Class**	**Area**	**Toys**
April 29th	Kinder	Art Centre	Glue sticks Pencil crayons Puzzle pieces Cupcake liners Coloured macaroni Feathers Crayons Scissors Tickets Buttons
		Book Centre	Books Giant jigsaws Matching puzzles Connectors Block puzzle
		Misc. Centre	Train table Trains Trucks Cars Human figurines
		Writing Centre	Rulers Pencil sharpeners Pencils Pens

			Erasers Paper Word templates
		Building Centre	Wooden blocks Connectors Coloured blocks Legos
		Sand table	Rice Rakes Watering cans Sieve Funnel Moulds Containers
May 11th	Jr.1	Sand table	Black beans Flower pots Watering cans Spades Gardening gloves Magnify glasses Rake Fake flowers Gardening books
		Water Table	Turkey baster Sea animals Scuba divers Water pump Lily pads Flowers
		Dramatic Play Centre	Menus Platters Plates Cups Teapots Jugs Aprons Cash register
		Building Centre	Lrg. Lego blocks Foam tube

		Puzzle Centre	Jigsaws Puppets
		Art Centre	Same as above
		Book Centre	Same as above
May 12th	Jr.2	Dramatic Play	Dress-up clothes Table cloth Place mats Food Pots, pans Plates, cups Phone Cash register Cookbooks Spatula, spoon, whisk
		All other centres remained the same	
June 4th	Jr.2	Building Centre	Train table Trains Human figurines Sm. connector blocks Wooden blocks
		Puzzle Centre	Ramps Magnet boards Wooden pizza blocks Connect-4 game
		Dramatic Play Centre	Stuffed animals Phone Tickets Dress up clothes Plates Dog dishes Dustpan and brush Phone Rug
		Art Centre	Paper Pencil crayons Crayons Stencils Beads

			Pipe cleaners
		Sand Table	Magazines Scissors
		Water Table	Sieves Funnels Bottles Turkey basters Puzzle pieces
		Misc. Centre	Key boards Pens Pencils Lego board Plastic letters
June 11th	Jr.1	Puzzle Centre	Wooden people Matching game Wooden doll Smelling containers Shakers, tambourine Alphabet puzzle Binoculars Stacking rings Texture books
		Water Table	Boats Containers Turtle
		Dramatic Play Centre	Birthday hats Tea set Plates Plastic cakes
		Art Centre	Paper Feathers Crayons Pompoms Tissue paper Foam shapes
		Building Centre	Train table Tracks Train cars

		Crane
	Sand table	Dinosaurs Funnels Containers Measuring cups, Spoons

Appendix 6

Outdoor Toy Inventory and Structures

Structures	**Toys**	**Natural specimens**
Fall tree trunk	Trucks	Trees
Climbing poles (10)	Buckets	Bushes
Swing set (4 swings)	Rakes	Grass
Slides (2)	Shovels	Leaves
Picnic tables (3)	Moulds	Rocks
Play house	Toy house	Sand
Sandpit		Pine cones
Fence		Twigs
Deck stairs		Insects
Ramp		

Appendix 7

Motor Model Excluding Focal Follows Shorter than Five Minutes

Random Effects

	Variance	**Std. Dev.**
Child ID (Intercept)	0.003162	0.05624
Residual	0.085764	0.29829

Fixed Effects

	Estimate	**Std. Error**	**t-value**	**p-values**
(Intercept)	1.25315	0.05693	22.011	0.000
Age group	-0.11971	0.02027	-5.907	0.000
Setting (outdoor)	0.05673	0.10414	0.545	0.589
Age group*Setting (outdoor)	0.11824	0.03778	3.129	0.001

Appendix 8

Object Manipulation Model Without Focal Follows Shorter than Five Minutes

Random Effects

	Variance	**Std. Dev.**
Child ID (Intercept)	0.001614	0.04017
Residual	0.187925	0.43350

Fixed Effects

	Estimate	Std. Error	t-value	p-value
(Intercept)	1.20548	0.06932	17.3906	0.000
Rank	0.03514	0.02423	1.4504	0.147
Setting (Outdoor)	-2.04456	0.05769	-3.5442	0.000

Appendix 9
Repetition VBA Macro

```
Public CalcState As Long
Public EventState As Boolean
Public PageBreakState As Boolean
Sub OptimizeCode_Begin()

Application.ScreenUpdating = False

EventState = Application.EnableEvents
Application.EnableEvents = False

CalcState = Application.Calculation
Application.Calculation = xlCalculationManual

PageBreakState = ActiveSheet.DisplayPageBreaks
ActiveSheet.DisplayPageBreaks = False

End Sub
Sub OptimizeCode_End()

ActiveSheet.DisplayPageBreaks = PageBreakState
Application.Calculation = CalcState
Application.EnableEvents = EventState
Application.ScreenUpdating = True
Application.StatusBar = ""

End Sub
Sub PrepSheet()

'Create Master List of Children and Actions
Columns("E:H").Delete
Columns("B:B").Select 'Child ID's
Selection.Copy
Columns("G:G").Select
Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks:=False,
Transpose:=False
Application.CutCopyMode = False
ActiveSheet.Range("$G:$G").RemoveDuplicates Columns:=1, Header:=xlNo
Columns("C:C").Select 'Action codes
```

```vba
Selection.Copy
Columns("H:H").Select
Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks:=False,
Transpose:=False
Application.CutCopyMode = False
ActiveSheet.Range("$H:$H").RemoveDuplicates Columns:=1, Header:=xlNo

'Get Exclusion List
Windows("Exclusion List.xlsx").Activate 'make sure to open exclusion list
Range("A1:A16").Select
Selection.Copy
Windows("Jr.1 indoor for macro.xlsm").Activate 'change to name of sheet
Range("J1").Select
Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks:=False,
Transpose:=False

'Remove Excluded Actions
For exc = 2 To 16
   Remove = Range("J" & exc).Value
   LastRow = Cells(Rows.Count, "H").End(xlUp).Row
   For i = 1 To LastRow
      If Range("H" & i).Value = Remove Then
         Range("H" & i).Delete
         Exit For
      End If
   Next i
Next exc
Range("J:J").EntireColumn.Delete

'Create new tab called Repetition
Application.DisplayAlerts = False
On Error Resume Next
ThisWorkbook.Sheets("Repetition").Delete
On Error GoTo 0
Application.DisplayAlerts = True
Sheets.Add(After:=Sheets(Sheets.Count)).Name = "Repetition"
Range("A1").Value = "Child"
Range("B1").Value = "Single Action"
Range("C1").Value = "Dyadic Actions"
Range("D1").Value = "Triadic Actions"
Range("E1").Value = "1"
Range("F1").Value = "2"
Range("E1:F1").AutoFill Destination:=Range("E1:S1")
Range("T1").Value = "FPL(1)"
Range("U1").Value = "ANI(2)"
Range("V1").Value = "CON(3)"
```

```
Range("W1").Value = "RTP(4)"
Range("X1").Value = "TRA(5)"
Range("Y1").Value = "NON(6)"
Range("Z1").Value = "CFP(7)"
Range("AA1").Value = "CAN(8)"
Range("AB1").Value = "TFP(9)"

End Sub
Sub Repetition()

Dim Length As Double
Dim A2D As Variant
Flip = 0

'Timer

StartTime = Timer

'Optimize Code
  Call OptimizeCode_Begin

ActiveWorkbook.Worksheets("Data").Select

Lengtha = Range("G:G").Cells.SpecialCells(xlCellTypeConstants).Count 'Get length of
child master list
Lengthb = Range("H:H").Cells.SpecialCells(xlCellTypeConstants).Count 'Get length of
action master list
'Lengthc = Range("A:A").Cells.SpecialCells(xlCellTypeConstants).Count 'Get length of
sheet
ActCount = 2 'Set start value for writing to Repetition tab

'Dyadic action repetition

'Try this
'       Selection.Find(What:="walk", After:=ActiveCell, LookIn:=xlFormulas, _
'       LookAt:=xlPart, SearchOrder:=xlByRows, SearchDirection:=xlNext, _
'       MatchCase:=False, SearchFormat:=False).Activate

For Child = 2 To Lengtha
    For Activity = 2 To Lengthb
        For Activity2 = Activity + 1 To Lengthb
            Application.StatusBar = "Child " & Child - 1 & " Action " & Activity & "/" &
Activity2
            CID = Range("G" & Child).Value
            NCID = Range("G" & Child + 1).Value
            Action = Range("H" & Activity).Value
```

```
Action2 = Range("H" & Activity2).Value
Range("E:E").EntireColumn.Clear
RndFlip = Int(2 * Rnd + 1)
For Flip = 1 To 2
   If RndFlip <> 1 Or Flip <> 1 Then
      TempAct = Action: Action = Action2: Action2 = TempAct
   End If

   'Find start and end of child/follow
   S1 = Application.Match(CID, Range("B:B"), 0)
   If NCID <> "" Then
      E1 = Application.Match(NCID, Range("B:B"), 0) - 1
   Else
      E1 = Range("A:A").Cells.SpecialCells(xlCellTypeConstants).Count
   End If

   For a = S1 To E1
      ID1 = Range("B" & a).Value
      Act1 = Range("C" & a).Value
      Flag1 = Range("E" & a).Value
      If ID1 = CID And Act1 = Action And Flag1 <> 1 Then
         For L1 = 1 To 3
            A2D = a + L1
            ID2 = Range("B" & A2D).Value
            Act2 = Range("C" & A2D).Value
            Flag2 = Range("E" & A2D).Value
            If ID2 = CID And Act2 = Action2 And Flag2 <> 1 Then
               'Find Repetition
               RepCount = 0: R2D = A2D
               Do While A2D = R2D
                  R2D = 0
                  For L2 = 1 To 3
                     R1D = A2D + L2
                     RID1 = Range("B" & R1D).Value
                     RA1 = Range("C" & R1D).Value
                     Flag3 = Range("E" & R1D).Value
                     If RID1 = CID And RA1 = Action And Flag3 <> 1 Then
                        For L3 = 1 To 3
                           R2D = R1D + L3
                           RID2 = Range("B" & R2D).Value
                           RA2 = Range("C" & R2D).Value
                           Flag4 = Range("E" & R2D).Value
                           If RID2 = CID And RA2 = Action2 And Flag4 <> 1 Then
                              Range("E" & a & ",E" & A2D & ",E" & R1D & ",E" &
R2D).Value = 1
```

```
                                        Range("F" & a & ",F" & A2D & ",F" & R1D & ",F" &
R2D).Value = 1
                                        EN = Range("D" & R2D).Value
                                        RepCount = RepCount + 1: A2D = R2D: a = R2D: Exit
For
                                      End If
                                    Next L3
                                  End If
                                Next L2
                              Loop
                              'Update Rep Values
                              If RepCount > 0 Then
                                Sheets("Repetition").Range("A" & ActCount).Value = CID
                                Sheets("Repetition").Range("B" & ActCount).Value = Action
                                Sheets("Repetition").Range("C" & ActCount).Value = Action2
                                Sheets("Repetition").Cells(ActCount, 4 + RepCount).Value =
Sheets("Repetition").Cells(ActCount, 4 + RepCount).Value + 1
                                Sheets("Repetition").Cells(ActCount, 19 + EN).Value =
Sheets("Repetition").Cells(ActCount, 19 + EN).Value + 1
                              End If
                            End If
                          Next L1
                        End If
Skip:
                      Next a
                      If Sheets("Repetition").Range("A" & ActCount).Value <> "" Then ActCount =
ActCount + 1
                    Next Flip
                  Next Activity2
                Next Activity
Next Child

'Single action Repetition

For Child = 2 To Lengtha
  For Activity = 2 To Lengthb
    Application.StatusBar = "Child " & Child - 1 & " Action " & Activity
    ID = Range("G" & Child).Value
    NID = Range("G" & Child + 1).Value
    Action = Range("H" & Activity).Value
    'Find start and end of child/follow
    S2 = Application.Match(ID, Range("B:B"), 0)
    If NCID <> "" Then
      E2 = Application.Match(NID, Range("B:B"), 0) - 1
    Else
      E2 = Range("A:A").Cells.SpecialCells(xlCellTypeConstants).Count
```

```
        End If

        For a = S2 To E2
           If Range("B" & a).Value = ID And Range("C" & a).Value = Action And
Range("F" & a).Value <> 1 Then
              'Repetition
              RepCount = 0: Start = a: Last = 0
              Do While Start > Last 'Subsequent Repetitions
                 Last = Start
                 For Rep = 1 To 3 'Immediate Repetition
                    Test = Range("C" & Start + Rep).Value
                    ID2 = Range("B" & Start + Rep).Value
                    SFlag = Range("F" & Start + Rep).Value
                    If Test = Action And ID = ID2 And SFlag <> 1 Then
                       RepCount = RepCount + 1
                       Start = Start + Rep
                       EN = Range("D" & Start).Value
                       Exit For
                    End If
                 Next Rep
              Loop
              If RepCount > 0 Then
                 Sheets("Repetition").Range("A" & ActCount).Value = ID
                 Sheets("Repetition").Range("B" & ActCount).Value = Action
                 Sheets("Repetition").Cells(ActCount, 4 + RepCount).Value =
Sheets("Repetition").Cells(ActCount, 4 + RepCount).Value + 1
                 Sheets("Repetition").Cells(ActCount, 19 + EN).Value =
Sheets("Repetition").Cells(ActCount, 19 + EN).Value + 1
                 a = Start
              End If
           End If
        Next a
        If Sheets("Repetition").Range("A" & ActCount).Value <> "" Then ActCount =
ActCount + 1
    Next Activity
Next Child

'Optimize Code
 Call OptimizeCode_End

EndTime = Int(Timer - StartTime) / 60
Application.StatusBar = "Runtime" & EndTime

End Sub
```